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World review of interactions between marine mammals and fisheries

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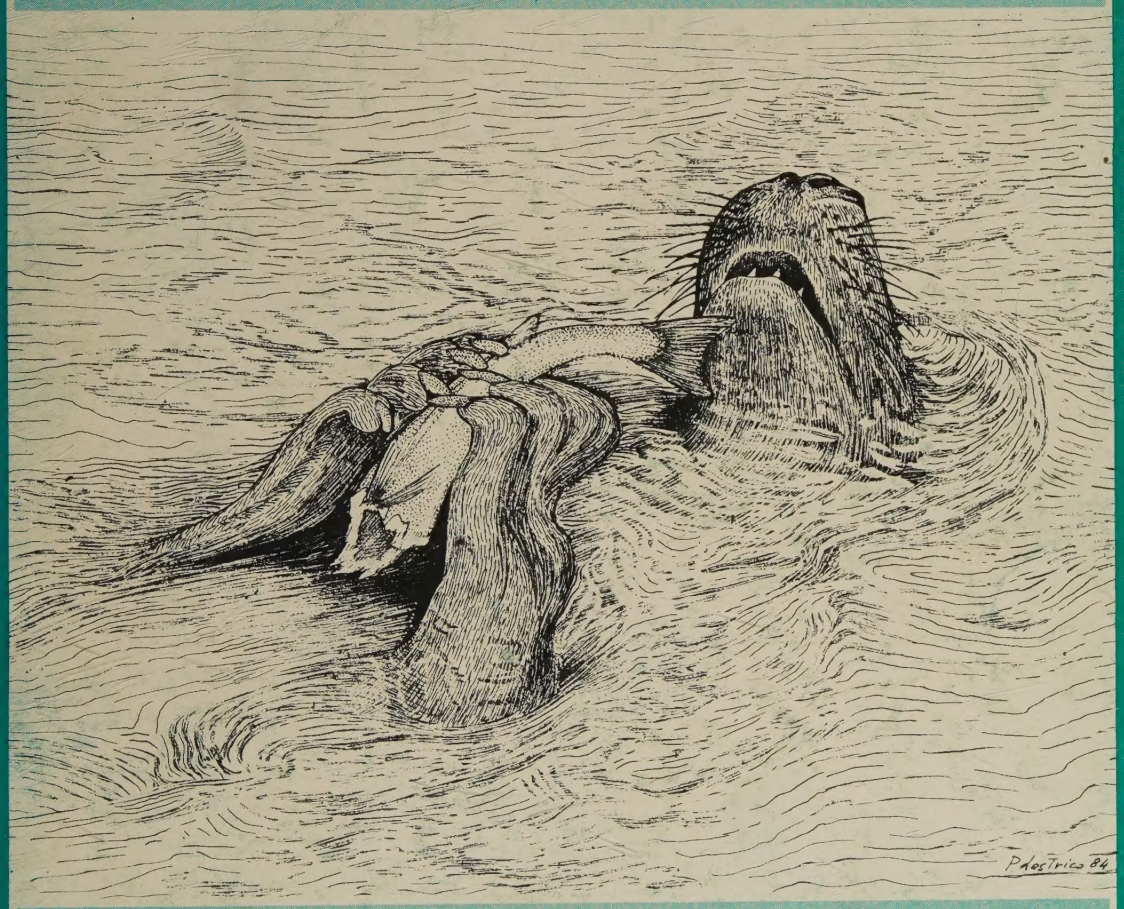

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FOOD
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UNITED NATIONS

World review of interactions between marine mammals and fisheries

by
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and Development
London, U.K.

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Cover picture

Grey seal eating a fish. Drawn by P. Lastrico from a photograph by the Sea Mammal Research Unit, Natural Environmental Research Council, c/o British Antarctic Survey, Cambridge, U.K.

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ABSTRACT

This report summarizes the available information on the distribution, abundance and feeding habits of cetacean, pinniped and sirenian mammals, as well as the information on interactions between these species and fisheries throughout the world. A catalogue of marine mammal species, their population sizes, distributions and diets, is followed by an area by area account of marine mammals, fisheries, and their interactions.

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1. INTRODUCTION

Interactions between Marine Mammals and Fisheries.

1.1 Background to the problem:

In 1972 COFI, FAO's Committee on Fisheries, taking account of the concern over some marine mammal stocks and their exploitation, recommended that FAO's Advisory Committee on Marine Resources Research should carry out a study of this problem. As part of this study ACMRR organised a meeting in Bergen in 1976. Papers presented there included some indicating the importance of the interaction between man and marine mammals in the sphere of fisheries.

At around the same time (1973) the IWC decided to set up a Small-Cetacean Sub-Committee, and in 1974 an IWC meeting was held in Montreal to discuss small Cetacea. Again, a number of the papers presented to that meeting included mention of the specific problem of interactions between marine mammals and fisheries.

In the mid seventies the dolphin culls at Iki Island and the ensuing controversy helped to nudge the IWC Small-Cetacean Sub-Committee into looking directly at this problem and others like it, and in 1976 the first marine mammal-fishery interactions were placed on the agenda of the sub-committee's meeting. Subsequently, the Commission agreed to ask member nations to supply information directly relevant to this problem. In the next few years the increased attention to the problem helped to produce enough concern for the International Union for the Conservation of Nature to organise a meeting at La Jolla in California in 1981 specifically to discuss the interaction between marine mammals and fisheries and to try to assess its nature.

1.2 The La Jolla meeting:

The meeting gathered together a number of papers related to the topic as background papers, and was presented with a total of 22 working papers which were discussed by a group of invited experts. The report of that meeting classified interactions into 5 different types. These were: damage by marine mammals to fishing gear, damage to catch, damage (or death) to marine mammals caused by fishing operations, (these three may be termed 'operational interactions'), transmission of parasites to commercial fish species from marine mammal intermediate hosts, and predatory interactions. This report surveys these interactions in detail.

1.3 Summary of types of interaction.

Operational interactions.
Operational interactions of whatever type depend on the sort of fishing gear being used and the ecology and behaviour of the marine mammal involved and of the fish being caught. Some types of gear are more prone to being damaged by marine mammals than others, and some inflict more damage on marine mammals than others. Similarly the fisheries for some types of fish are irrelevant to marine mammals, whilst other types of fish are closely bound up with the interaction between marine mammals and fisheries. For example, purse-seine nets are more likely to catch marine mammals accidentally than are bottom trawls if marine mammals spend more time near to the surface than the bottom. Similarly, fish such as salmon, which regularly congregate near certain areas are more likely to attract marine mammals, and hence provoke gear conflicts, than are more solitary fish such as sharks.

Types of gear
Gear categories have been described by Nedelec (1982), whose classifications are followed here. 11 categories are defined as follows:

i) Surrounding nets: nets which catch fish by surrounding them from the sides and from below, thereby preventing them from diving below the net. These nets are often very large (e.g. some purse-seine nets), and are often involved in incidental catching of marine mammals which cannot then escape by diving. In tuna purse seines, some dolphins 'faint' and, sinking into the bottom of the purse, become entangled and

drown. The fact that these nets corral large numbers of fish at high densities and are open at the surface has also led to their being exploited by some marine mammals, especially cape fur seals, which are able to clamber over the float line and into the mass of encircled fish.

ii) Seine nets: operate by surrounding a large area of water with very long nets and then herd the fish toward the point of capture, often entangling them on the way. One of the most common is the beach seine net, operated from land in shallow water and usually set by a boat, the net is dragged in and acts as a barrier to fish inside the enclosed area. This type of net is known to catch coastal marine mammals which feed in shallow waters, such as Tursiops sp., and which become entangled in the net along with shallow water fish.

iii) Trawl nets: towed nets consisting of a cone-shaped net with a codend or bag for collecting the fish. These can be bottom, midwater or surface nets, and are operated from one, or occasionally two, boats. Marine mammals have been known to be caught in bottom trawls, presumably when feeding on fish caught therein, and in surface trawls, which may or may not be coincident with their feeding.

iv) Dredges: gear which is dragged along the bottom usually to collect sessile molluscs. The opening into the collecting net is therefore not usually very large, and the entrapment of a marine mammal would be very unusual.

v) Lift nets: nets which are first submerged so that they lie horizontally underwater, until fish, which may be attracted by bait or light, are above the net. The net is then lifted by one of a number of means out of the water, taking fish with it. Such nets are normally relatively small and would not usually be involved in operational interactions with marine mammals.

vi) Falling gear: nets which catch fish by falling on top of them. Such gear is usually small and hand operated, i.e. thrown or dropped, and is operated in shallow water. It would be unusual for such nets to catch a marine mammal unintentionally, unless a very small animal was involved, or the operation was in murky waters.

vii) Gill nets and entangling nets: fish are gilled, entangled or enmeshed in such gear, which may be operated as surface, midwater or bottom gear, depending on the ballasting and bouyancy. Gill nets are usually a single sheet of netting, whereas trammel nets have three layers, designed to entangle rather than to gill. These nets are often found in enormous lengths over parts of the oceans, e.g. in the North Pacific, for salmon fishing, and frequently are responsible for the entanglement of marine mammals. The type of gill net used can often be very important in determining the effect on a specific marine mammal. Midwater gill nets for example, may be more likely to ensnare and subsequently drown some species than surface nets, where the animals may still be able to breathe. Also, synthetic nets (not just gill nets though) are more likely to ensnare marine mammals than natural fibres. Such netting is strong and durable, and unlike natural fibre nets is very difficult for an entrapped mammal to break out of; furthermore fragments having broken loose may float around in the sea for a considerable length of time. The relative economy of these nets has also meant that there has been a great proliferation of their use.

viii) Traps: Traps may be large or small, staked or buoyed, wicker or netting, and are usually used only in shallow water. Small wicker or metal traps such as are used on reefs present few problems with regard to marine mammals, but larger pound nets (fixed nets), fyke nets or stow nets may do so. Marine mammals may enter such nets after fish, damage the nets and/or the catch, and may also become trapped themselves.

ix) Hooks and lines: these include handlines, pole-lines, longlines (multiple hooks on long lines) or trolling lines (lines trailed by boat near the surface). These types of line attract marine mammals as they often provide easily taken wounded fish of a medium to large size. Rarely are the marine mammals themselves caught on such lines, but certain species frequently cause annoyance and loss to fishermen in numerous areas of the world, by removing or damaging fish from such gear.

x) Grappling and wounding: gear for grappling, wounding or killing, including spears, arrows, prongs, tongs, clamps and harpoons. The only involvement such gears have with marine mammals is probably in directed fisheries, where harpoons and spears are used for catching the mammals themselves.

xi) Harvesting gear: includes pumps and dredges, which suck fish or molluscs directly out of the water. This type of gear does not include pumps used in purse seining and other net fisheries, and can only be used in special circumstances and for a few species, where they can either be attracted directly to the pump, or where they can be relied upon to remain in the same location whilst being harvested (e.g. some molluscs and crustacea). There are unlikely to be many instances of operational interaction between such gear and any marine mammals.

The type of gear being used is not the only aspect of the fishing operation which may determine the nature or extent of an operational interaction with marine mammals. The area being fished, whether it is in shallow or deep water may also be important, especially in determining which mammal species are involved. The size of the fishery itself will affect the extent of any interaction, and where the interaction involves a marine mammal feeding on the same species as is being caught, then obviously the nature of the species is also important.

Types of fish - types of marine mammal.
Numerous factors in the behaviour and ecology of marine mammals and their prey are involved in determining the extent of the operational interaction. These factors may broadly be divided into two groups. Firstly the habitat of the marine mammal and the fish may be an important group of considerations. An inshore fish stock is therefore unlikely to involve any interaction between the associated fishery and an offshore marine mammal population. Similarly a demersal fishery may be less likely to involve marine mammals which are primarily pelagic than those which may feed on demersal fish, and a fishery for reef fish is unlikely to involve marine mammals which are associated with open water. Other distinctions may be envisaged whereby the habitat of marine mammals and fish stocks either lessens or increases the likelihood of gear conflicts.

Secondly, the availability of the fish may influence the degree to which operational interactions between fisheries and marine mammals may occur, as this may be important in determining what type of fishery is in operation and how the fishery will affect marine mammals. For example, small pelagic and numerous fish are likely to be caught by purse seines or surface trawls, whereas large demersal solitary and rare fish are more likely to be caught on traps or hooks and lines, and this in turn will influence any gear interaction with marine mammal species.

Factors such as those mentioned above may be important in determining the type of gear employed in a fishery and the type of operational interaction with marine mammals, but they may also be even more important in determining the nature of the inter-species, or biological interaction. This is discussed briefly below.

Inter-species interactions.
The transmission of parasites is one type of interaction between marine mammals and fish which has received relatively less attention than other types of interaction. In brief, certain fish parasites are known to use marine mammals in their cycles; commercial fish are then infected, and their value greatly reduced. The most notable example of this is found in grey seals, which harbour the codworm, Porrocaecum decipiens, which also infects cod.

Predatory interactions between marine mammals may be divided into 5 categories:

a) depleted mammal stocks may not recover due to heavy fishing of their food supply,

b) mammal stocks which have not been depleted may be threatened by overfishing of their food supply

c) increasing predation by recovering mammal stocks may start threatening fish stocks

which are already exploited,

d) abundant mammal stocks may threaten continued expansion of a new fishery, or continued existance of a heavily fished stock,

e) changes in population size of marine mammal may also indirectly affect the population dynamics of exploited species,

In all of the above, the threat posed by marine mammals to fisheries or vice versa can either be 'direct' through the medium of a common prey species, or 'indirect' via tertiary species which are prey species common to both mammal and commercial fish.

1.4 Aim of this study.

The aim of this study is to catalogue as many reported interactions as possible and attempt to identify potential ones, with regard to the general impact that such interactions may have on either the fishery or the marine mammal population. To this end a brief summary of the distribution and feeding habits all nominal 114 species of marine mammals is presented. This is followed by an area by area survey of the world's marine areas, listing the mammal species present together with brief notes on the main fisheries and the known and potential interactions between the two. Finally an attempt is made to draw some general conclusions.

1.5 Notes on the text.

i) Species described.
The text includes discussion on all species of extant Cetacea, Sirenia and the pinnipeds, including mention of one phocid species presumed to be extinct. For the sake of wholeness and convenience, those species of these groups which are wholly or partly freshwater have been included, on the basis that they belong, taxonomically, to an order or family that is characteristically marine.

Other species, notably the 'marine otters', which are primarily freshwater but which inhabit marine environments have been excluded for the corresponding reason.

ii) Taxonomy.
The species described follow the taxonomy of the following authorities: Cetacea - as described by the IWC, including the list of small cetaceans currently recognised, supplied by the Small-Cetacean Sub-Committee, (IWC 1977) with minor subsequent amendments. Sirenia and the pinnipeds - as described in the FAO/ACMRR reports of the 1976 Bergen meeting on Marine Mammals, and in the volumes "Mammals in the Sea". Fish names are taken, where appropriate from the FAO Yearbook of Fisheries Statistics - Catches and Landings (FAO 1983).

iii) Distribution.
Each species described in the text is followed by a list of the FAO statistical areas in which it has been recorded. Area numbers bracketed indicate doubtful or unconfirmed presence.

iv) Statistical areas.
The statistical areas covered are the FAO statistical areas for major fishing areas of the world, as described in the FAO Yearbook of Fisheries Statistics. These areas are illustrated in the map on page 191.

2. SPECIES ACCOUNTS: MARINE MAMMALS OF THE WORLD

2.1 CETACEA

Mysticeti

BALAENIDAE

Eubalaena glacialis Muller 1776 Right whale
The range of this species used to include all temperate waters of the North Atlantic, North Pacific, and southern hemisphere (Rice and Scheffer, 1968). Tomilin (1967) gives a more detailed account of its distribution, as do the whaling maps of Townsend (1935). The distribution of stocks is discussed in detail by the Report of the (1983) Workshop on the Status of Right Whales (IWC/35/Rep2). Berzin and Vladimirov (1981) state that the population in the North Pacific used to number around 10 000 before exploitation, but that currently only around 200-500 remain. The Report of the Status of the Right Whale Workshop lists other estimates of population sizes and numbers of whales sighted in a number of areas worldwide, indicating a total world population of at least 2 000. The report also summarises information on feeding habits of this species. Tomilin (1967) states that the main food in the North Atlantic is the calanoid copepod C. finmarchius, and the schizopod Thysanoessa inermis. Omura et al (1969) also report that the main food is calanoid copepods in the North Pacific. Tomilin states that no fish have ever been found in stomachs of this species, and adds that the right whale is now extremely rare. A few animals are known to become entangled in fishing gear. (See areas 21, 57 and 41).

21 27 31 34 37 41 47 48 51 57 58 61 67 77 81 87 88

Balaena mysticetus Linnaeus 1758 Bowhead whale
Confined to Arctic waters, or floating ice areas (Tomilin 1967). There are 4 or 5 stocks in the Arctic waters, all of which have been decimated by commercial whaling over 4 centuries. Braham (1982) estimates the current population size to be around 5 000 in all, which is around 5-10% of the original population size. Some stocks are more depleted than others, the Spitzbergen stock possibly being extinct (see area 27). Townsend (1935) provides a map of the original distribution of this species in the North Pacific area, as represented by whaling catches. Calanus finmarchius is the main food in the North Atlantic (Tomilin 1967), and pelagic copepods and euphausids form most of the diet in the Bering Sea area (Marquette et al 1982). Tomilin states that fish are not eaten, and no interactions with fisheries have been recorded.

18 21 27 61 67

Caperea marginata (Gray 1846) Pygmy right whale
Ross et al (1975) describe the distribution of this species, based on 71 recorded individuals at that time, as circumpolar in the southern hemisphere, north of the Antarctic convergence, and south of about 31°S. They suggest the northern distribution may be limited by the 20 degree isotherm. Citing Ivashin et al (1972), Ross et al state that Caperea feeds mainly on copepods and that as such its distribution patterns probably follow those of sei and right whales in the southern hemisphere. This species has occasionally been caught accidentally in beach seines in South Africa (see area 47). No population estimates are possible, but it cannot be considered common, even though it has never been exploited.

41 47 51 57 81 (87)

ESCHRICHTIDAE

Eschrichtius robustus (Lilljeborg, 1861) Grey whale
Hershkovitz (1966) describes the distribution of this species as extending from around 72°N in the Oriental Arctic, southwards to Mexico in the east and to Japan and Korea in the west. Of the 2 stocks, the eastern Pacific stock has recovered from a few thousand at most in the 1880's to 1930's, to an estimated 11 000 today, from an initial population of about 15 000 (see area 77). The western stock is near extinction (see area 61), and a 3rd

stock, in the Atlantic went extinct some centuries ago (Hershkovitz 1966). Zimusko & Ivashin (1980) state that although they have identified 70 different food species, the main food is amphipods. Little interaction with fisheries is known. Wolman & Rice (1979) suggest that increased boat traffic in the breeding lagoons in Mexico, some of which is fishing boats, may jeopardise breeding. A few whales are known to get entangled in gill nets in California (see area 77)

18 61 67 77

BALAENOPTERIDAE

Balaenoptera physalus (Linnaeus, 1758) Fin whale
According to Tomilin (1967) this species is found in all oceans, and is particularly abundant in the Antarctic "in warm weather". It is not so abundant in the northern hemisphere, but is still the dominant species of baleen whale there. It is more common in the North Pacific than the North Atlantic, and rare in the tropics, rarer than the blue whale. Tomilin gives a detailed description of the distribution.

Gambell (1976) gives estimates for the original population sizes of the various stocks before whaling. The initial world total population size may have been around 700 000. The North Atlantic population of fin whales has been divided into 7 non interbreeding management stocks by the IWC (see Rorvik & Jonsgaard 1981). The latest figures for stock sizes in these areas total 11 550 (IWC 1984: Report of the Sub-Committee on Other Baleen Whales; IWC 1977: Report of the Sub-Committee on North Atlantic Whales). Using Gambell's (1976) conversion figure of total population being 1.5 times the exploitable stock size, the total population of the North Atlantic may exceed 17 000. In a similar manner the IWC has estimated the stock sizes for the southern hemisphere at around 82 000 (IWC 1979: Report of the Sub-Committee on Protected Stocks; IWC 1981: Report of the Sub-Committee on Other Baleen Whales), which would suggest a total population of around 122 000. There are no recent IWC estimates for North Pacific stocks, but these are presumably nearer to the size of the Atlantic population than the southern hemisphere. (Gambell (1976) gives a figure of 24 000.) A world total population therefore might not exceed 163 000 animals.

Tomilin (1967) gives detailed accounts of feeding around the world which includes a number of small pelagic schooling fish species, such as herring, smelt, capelin, arctic cod and sand eels, as well as some larger fish such as cod and salmon, and a number of pelagic crustacea. The diet is much more varied in the northern hemisphere than the southern, as this species shares the feeding, and breeding, habits of other baleen whales in the Antarctic, feeding on krill (largely Euphausia superba) in the summer and fasting in more northerly latitudes in the winter. There has been some reported interaction with fisheries, although all such instances have been of an operational nature (see areas 21 and 37).

18 21 27 31 34 37 41 47 48 51 57 58 61 67 71 77 81 87 88

Balaenoptera musculus (Linnaeus, 1785) Blue whale
Another cosmopolitan species which according to Tomilin (1967) prefers colder waters and shuns coastal zones. He states that large numbers are found in selected areas, around South Africa, South America, and Australia in the austral winter, and that there are "incomparably fewer" in the northern hemisphere. In the south, the usual baleen whale habits are observed as regards feeding and breeding. In the northern hemisphere the food is, again according to Tomilin, macroplankton, especially Thysanoessa inermis, and not fish. Nemoto (1959) states that blue whales prefer euphausiids in the North Pacific. The northern stocks winter in subtropical belts. It is worth noting that Ichihara (1966) first noted the presence of smaller blue whales, which he called B. brevicauda, in the summer north of the Antarctic convergence in the Indian Ocean. Other people have also noted the presence of blue whales in the subtropical and even tropical belt in summer. Berzin (1978) saw a considerable number in the eastern tropical Pacific in June, and Tomilin states that not all whales migrate to the poles in summer.

Gambell (1976) suggests that the initial population throughout the world may have totalled around 250 000, and that at present it numbers around 10 000, three quarters of

which are in the southern hemisphere. Gulland (1981) suggests that the total population in the southern hemisphere is around 10 000, whilst Grenfell (1981) puts the figure for the total population of Antarctic areas II, III, and IV at over 20 000. Clearly there is no satisfactory world population estimate, but this cannot be more than a few tens of thousands. There have been no records of interaction between this species and fisheries anywhere, as yet.

18 21 27 31 34 41 47 48 51 57 58 61 67 71 77 81 87 88

Balaenoptera acutorostrata Lacepede, 1804 Minke whale
Minke whales occur from the edge of the ice in both Arctic and Antarctic seas to the tropics, but according to Tomilin (1967), are rare in the tropical areas. In the southern hemisphere they exhibit the usual baleen whale characteristics of feeding on krill and migrating to fairly well defined breeding sites in the winter. In the northern hemisphere they are perhaps, again according to Tomilin, the most icthyophagous of baleen whales, feeding on a wide range of schooling fish, especially herring and capelin, but also cod, whiting and pollack.

The latest Report of the Sub-committee on Minke Whales (IWC 1984) suggests that a reasonable figure for the total population of minke whales in the southern hemisphere might be around 580 000. Only two other stock sizes have been estimated, that of the exploited Barents Sea population may total 60 - 90 000 animals, and that of the Korean stock as much as 14 000 (IWC 1984) animals in all. There are no estimates of a world population size, but if, as is the case for other baleen whales, the southern hemisphere stocks are larger than the northern hemisphere ones, then there are unlikely to be more than 1 million animals in all. Minke whales, being small, have not until recently been the subject of much commercial exploitation, although since 1975 catches have been in the region of 5 - 10 thousand per year worldwide (Brown 1982). Minke whales are known to become trapped in Canadian and other fishing nets (see areas 21, 37 and 61) and have also drawn comment in Norway for their icthyophagous habits (see area 27).

18 21 27 31 34 37 41 47 48 51 57 58 61 67 71 77 81 87 88

Balaenoptera borealis Lesson, 1828 Sei whale
Occurring in all oceans of the world up to the ice, but Tomilin (1967) states that it is more warmth loving than physalus, and is rare south of the Antarctic convergence or north of Japan or east of the North Cape in Norway. Tomilin also states that sei whales do not migrate as regularly as other baleen whales and are often found in shallow waters. The diet consists of both pelagic crustacea and small schooling fish, although Kawamura (1974) states that in the southern oceans borealis feeds almost exclusively on copepods and euphausiids. Nemoto (1959) also states that they prefer copepods in the North Pacific, agreeing with Tomilin, who asserts that they are less well adapted to eating fish than are fin or humpback whales. The world population was estimated by Gambell (1976) to have been around 300 000 prior to exploitation, and to be around 110 000 at present. The Report of the Special Meeting on Sei Whales (IWC 1980) however, suggests that there are only 15 - 30 000 sei whales in the southern hemisphere, so that 110 000 may be considered optimistic for the world population. There have been no reported interactions between this species and any fisheries as yet.

21 27 31 34 41 47 48 51 57 58 61 67 71 77 81 87 88

Balaenoptera edeni Anderson, 1878 Bryde's whale
Ivashin (1980) gives a comprehensive account of the distribution of this whale, which although centred on the tropics extends as far north as 43°N in the Pacific, and around 37°S in the south. The distribution of this species may be limited by the 15° isotherm (NCC 1980). There is apparently not enough information as yet to distinguish separate stocks, nor to make any reliable population estimates. The fact that the catch statistics of this species used to be included in the statistics for sei whales also makes an assessment of the status of this species very difficult (NCC 1980). Nemoto (1959) lists anchovies, Yarrella sp., Myctophum sp., and horse mackerel, as well as euphausiids as food items in the diet of this species in North Pacific waters. Omura (1966) also states that both small fish and euphausiids are eaten in the North Pacific. As yet there are no reports of interaction with fisheries although this whale is known to feed on the same

stocks of small fish as are fished for commercially (see e.g. Best 1967).

21 31 34 41 47 51 57 61 71 77 81 87

Megaptera novaeangliae (Borowski, 1781) Humpback whale
Humpbacks are found in all oceans, performing long migrations from feeding grounds in colder waters to breeding grounds in warmer ones. Tomilin (1967) states that at least 10 such migration routes are known, one on each side of the North Pacific and Atlantic, whilst humpbacks feeding in Antarctic waters migrate to the coasts of Zaire, Madagascar, Peru, Australia, New Zealand and Tonga to breed. Townsend's (1935) maps of whale distribution clearly show concentrations around each of these areas, two such occurring off Australia. In Antarctica humpbacks feed on krill inside the Antarctic convergence, whilst in the northern hemisphere, feeding occurs as far north as the Chukchee Sea, and Svalbard, the diet here consisting of a number of small fish species, notably Capelin (Mallotus villosus), and other fish of the families Clupeidae, Osmeridae, Gadidae, Salmonidae, Ammodytidae, and Hexagrammidae, as well as pelagic crustacea (Tomilin 1967). Chittleborough (1965) refers to some limited feeding during migration of southern stocks, on pelagic decapod crustacea, but he thought this was of minor importance.

There do not appear to be reliable estimates for all of the stocks, but Berzin and Vladimirov (1981) suggest that the North Pacific stocks number about 1 500, or maybe a tenth of their initial population size. There are estimates of the North West Atlantic stock ranging from less than 1 000 to more than 4 000 (see area 21), but this stock was probably never as large as the Pacific ones, and may be fully recovered now (NCC 1980). The Eastern Atlantic population size is unknown, but a few hundred individuals have been sighted (Annex G, IWC 1983). Gambell (1976) suggests that the total population in the southern oceans may be only around 3 000, from an initial stock size of around 100 000.

Humpbacks have been implicated in a few interactions with fisheries in the northern hemisphere. There have been a number of entanglements in fishing nets in Canada, and there has been a suggestion that the over-exploitation of the capelin stocks there have also led to a reduced recruitment to the humpback population (see area 21). In area 61 there have also been reports of whales annoying salmon fishermen (Tomilin 1967).

18 21 27 31 34 41 47 48 51 57 58 61 67 71 77 81 87 88

Odontoceti

ZIPHIIDAE

Tasmacetus shepherdi Oliver 1937 Shepherd's Beaked Whale
Like most of the beaked whales this species has only rarely been recorded. Mitchell (1975) states that it was known from only about 8 specimens, all from New Zealand and South America. Obviously population estimates are impossible on the basis of such limited information. Mead and Payne (1975) have suggested that the diet may consist of deep water bottom dwelling organisms, on the basis of the stomach contents of their specimen from Argentina, which consisted of the hake Merluccius hubbsi, a serranid, brotulid remains, which formed the bulk of the food, as well as some crab and squid remains. There have been no recorded operational interactions with fisheries yet, and the implications of the fact that commercial fish species are included in the diet remain obscure at present.

41 81 87

Berardius arnuxii Duvernoy, 1861 Arnoux's Beaked Whale
Mitchell (1975) states that this species has been recorded from New Zealand, South Australia, the Falkland Islands, Argentina, South Africa, South Georgia, South Shetlands and the Antarctic Peninsula. Again this indicates a southern circumpolar distribution of a population of unknown size. McCann (1975) also states that this species is not found north of about 30^{o}S, and that it feeds on cephalopods. No interactions with fisheries are known anywhere.

41 47 48 51 57 58 81 87 88

Berardius bairdii Stejneger, 1883 Baird's beaked whale
Confined to the North Pacific, in offshore waters from the Pribilof Islands and Alaska to southern California on the one side, and from the Sea of Okhotsk to southeast Japan on the other (Mitchell 1975). The diet consists mainly of squid, Gonatus fabricii and Onychoteuthis sp. having been found in the stomachs of North East Pacific specimens (Rice 1963). There is a small fishery in Japan, much reduced in recent years from a few hundred in the 1950's (Mitchell 1975) to around 30 in 1981 (IWC 1982 p 125). According to Ohsumi (1975) there has been no decrease in the catch per unit effort however, so the stocks are presumed not to be depleted. There are no records of interactions with fisheries.

61 67 77

Mesoplodon spp.
12 species have been recognised in this genus (Moore 1966), yet almost all of these remain virtually unknown. Most seem to feed on squid, as attested to by the characteristic reduction in dentition (Gaskin 1976), though Mitchell (1975) thought that a variety of fish may also be taken. In general they are associated with deep water, and occur in small groups (Mitchell 1975). Moore (1966) has suggested that the distibution of those species recorded around American waters at least, approaches allopatry . This is not so clear for a number of other species, however, where distribution at present seems to be largely conjectural. Almost all of them should be regarded as rare on the basis of the number of animals seen, though their apparent shyness of boats and often remote habitat may lend some bias to this suggestion; no population estimates are possible for any of the species (NCC 1980). Interactions with fisheries are almost unknown (but see below: M. ginkgodens), and are at any rate unlikely to be significant in any species due to their squid - eating habits and apparent scarcity.

Mesoplodon pacificus (Longman, 1926) Longman's beaked whale
Only two individuals have ever been definitely identified, one in Australia, the other in Somalia (Azzaroli, 1968), but Keller et al (1982) report that they saw beaked whales which may have been of this species near the Seychelles. If the distribution of this species is continuous then its range should extend over the Indian Ocean and Indo-Pacific region.

51 (57) 71

Mesoplodon bidens (Sowerby, 1804) Sowerby's beaked whale
According to Moore (1966) this species is inferred to inhabit the North Sea and adjacent waters, straggling to the North American coast.

21 27 37

Mesoplodon densirostris (de Blainville, 1817) Blainville's beaked whale
Otherwise known as the dense-beaked whale, this is possibly the most widely distributed of all Mesoplodon species. It has been reported from tropical and warm temperate waters of the Indian Ocean, the South Pacific, the southern North Atlantic, and the North Pacific (NCC 1980).

21 31 34 (41) 47 51 (57) 61 71 77 81

Mesoplodon europaeus (Gervais, 1855) Gervais' beaked whale
Moore (1966) suggests that this species is centred on the Antillean region, straggling northwards to New York and to England on the Gulf stream. Rankin (1953) reported that at that time there were only 6 records of this species.

21 27 31

Mesoplodon layardii (Gray, 1865) Strap-toothed whale
Hershkovitz (1966) records this species from Australia, New Zealand, and the mid south Atlantic. Leatherwood and Reeves (1983) add South Africa, Uruguay, the Falkland Islands and Tierra del Fuego. They suggest a distribution outside Antarctic waters with a northern limit of about 30°S.

41 47 51 57 71 81

Mesoplodon hectori (Gray, 1871) Hector's beaked whale
Leatherwood and Reeves (1983) suggest a temperate southern hemisphere distribution extended to the temperate eastern North Pacific, specimens having been found in Tierra del Fuego, New Zealand, Tasmania, South Africa, the Falklands Islands and California.

41 47 57 77 81

Mesoplodon grayi von Haast, 1876 Gray's beaked whale
At first sight, another species with a circumpolar southern hemisphere temperate distribution (NCC, 1980). Watson (1981), however, cites Boschma's (1950) record of a stranding in Holland. The distribution of this species therefore remains unclear.

27 41 47 51 (57) 81 87

Mesoplodon stejnegeri True, 1885 Stejneger's beaked whale
Hershkovitz (1966) gives this species a North Pacific distribution, from Akita beach in Honshu, Japan, to the Bering Sea and to the Oregon coast of North America. Moore (1966) considered that its main area of distribution was the sub-arctic North Pacific, with stragglers occuring further south. Leatherwood and Reeves (1983) state that strandings are fairly common in the Aleutians, suggesting the species may be most numerous in that area.

61 67

Mesoplodon bowdoini Andrews, 1908 Andrew's beaked whale
According to Leatherwood and Reeves (1983) this species has so far been recorded only from strandings in New Zealand, Tasmania, Western and Eastern Australia, and Kerguelen Island but Nishiwaki (1962) also records a specimen from Akita beach in Honshu, Japan. If distribution is continuous, then this species should also occur in area 71.

57 61 (71) 81

Mesoplodon mirus True, 1913 True's beaked whale
Moore (1966) considers that this species may inhabit primarily deep waters of the continental shelf off the mid-Atlantic States of the USA, straggling north wards to Europe. A number of specimens have also been recorded from South Africa (IWC 1980), once again making the distribution of this species somewhat conjectural.

21 27 31 47

Mesoplodon ginkgodens Nishiwaki & Kamiya, 1958 Ginkgo-toothed beaked whale
This species has been found in Japan, Taiwan, California and Sri Lanka (Leatherwood and Reeves 1983). Watson (1981) refers to "at least 2" further, unconfirmed, records of animals being taken on Japanese longlines near Taiwan, which might indicate a diet of fish as well as the presumed diet of squid, though longlines are often baited with squid. Leatherwood and Reeves (1983) suggests that on the basis of the location of strandings to date, this species is the most common in the Western North Pacific.

51 (57) 61 (71) 77

Mesoplodon carlhubbsi Moore, 1963 Hubb's beaked whale
Moore (1966) states that this species is found in the North Pacific temperate waters, generally to the south of the area inhabited by M. stejnegeri. Leatherwood and Reeves (1983) suggest it may be limited to the waters around Honshu in the Western Pacific, and from Vancouver to San Diego in the east.

61 67 77

Ziphius cavirostris G. Cuvier, 1823 Cuvier's beaked whale
Apparently found in all seas, but rarely polar ones (NCC 1980), there are numerous reports of strandings of this species from all over the world, which indicates that it

may be relatively common. Tomilin (1967) however states that whereas it is found in all oceans it is not numerous in any; Tomilin also states that like all squid eating beaked whales, this is a pelagic species. Erdman's (1962) specimen from Puerto Rico contained only squid in its stomach, but Mitchell (1975) states that in some areas deep water fish may predominate. It has been subject to some small scale hunting in mixed small whale fisheries in Japan and St Vincent (Mitchell 1975a) but has not, it would appear, been involved in any interaction with fisheries anywhere.

21 27 31 34 37 41 47 51 57 61 67 71 77 81 87

Hyperoodon ampullatus (Forster 1770) Northern bottlenose whale
Found throughout the North Atlantic, from the Arctic Ocean, Spitzbergen and Greenland (Mitchell 1977) to Rhode Island, Cape Verde and the Mediterranean (Tomilin, 1967). Benjaminsen (1972) states that it avoids shallow waters, preferring those mostly greater than 1 000m in depth, or according to Mitchell (1977) submarine canyons. Food is principally cephalopods, chiefly Onycoteuthis, Loligo and Sepia spp. according to Tomilin, or Gonatus fabricii according to Benjaminsen. Tomilin also states that either by accident or in supplement, some fish are also taken, such as herring and cod, and also starfish and holothurians. Mitchell (1977) maintains that the population is currently depleted after centuries of hunting, notably by the Scots and Norwegians. There are no records of direct interaction with fisheries however.

21 27 37

Hyperoodon planifrons Flower, 1882 Southern bottlenose whale
A circumpolar southern hemisphere species, reported from South America, South Africa, Australia, New Zealand and the Indian and Pacific Ocean coasts of Antarctica (NCC 1980). Mitchell (1975) states that it is widespread throughout the range, and cites Hale (1931) that the stomach of one specimen was full of squid remains. He also states that this species is occasionally taken by whalers in the Antarctic waters. There are no interactions with fisheries at present, nor would any seem likely.

41 47 48 51 57 58 81 87 88

PHYSETERIDAE

Physeter macrocephalus Linnaeus, 1758 Sperm whale
Found in all seas, chiefly between 40°S and 40°N. Females are found in subtropical zones, whereas males may be found as far as the polar ice fields (Tomilin, 1967). Townsend's (1935) maps also show the distribution of sperm whales throughout the year. Tomilin states that the distribution of sperm whales is limited by the distribution of cephalopods, on which they feed, and which tend to prefer warmer, more salty waters. Numerous presumed feeding grounds are evident in Townsend's maps, notably along the equator in the Pacific basin ("On The Line"), off Angola ("Carroll Ground"), and in the central North Atlantic (Charleston, Western, and Twelve Forty Grounds). Sperm whales have been hunted for centuries, and at present continue to be in the Pacific.

There are no accurate assessments of population sizes, but Gambell (1976) thought that the male populations in the southern hemisphere and the North Pacific were about half of the initial population size, and the female stocks in both areas were reduced by about a third. By his estimates the total population of males and females in both of these areas is a little more than one million animals. He also estimates the total population in the Atlantic as currently around 22 000. Some later individual stock assessments are given in the area accounts.

Sperm whale diet has been studied in a number of regions throughout the world, notably in the North Pacific. Clarke (1980) and Berzin (1972) both give useful summaries of information on sperm whale diets. Berzin states that 25 species of squid have been identified in sperm whale stomachs, the most important being squids of the families Gonatidae, Onychoteuthidae, Histioteuthidae and Ommastrephidae. Berzin also states that Betesheva found more than 24 species of fish in sperm whale stomachs; between 12% and 30% of stomachs of whales from the northwestern Pacific had some fish in them over a number of

years. Mizue (1951), however found fish in only 3.4% of stomachs which he analysed. The most important fish species found were from the families Macruridae, Gadidae, Cottidae, Scorpaenidae as well as sharks and rays. There appears to be only one reported instance of any interaction between sperm whales and fisheries (see area 37). The only significant area of overlap in prey species occurs with the squid species Todarodes pacificus, which is both eaten by sperm whales and fished for around Japan.

18 21 27 31 34 37 41 47 48 51 57 58 61 67 71 77 81 87 88

Kogia breviceps (de Blainville, 1838) Pygmy sperm whale
Distributed mainly in "tropical and warm waters" (Mitchell, 1975). Tomilin (1967) states that it occurs as far as Holland, Nova Scotia, Japan, Southern California, and the Kuril Islands in the northern hemisphere, and as far as the Cape of Good Hope, Tasmania, and Chile in the southern hemisphere. Records from South America and Africa are scarce (Handley, 1966), but this may be due to the fact that they are not noticed so much in such areas. There are no estimates of population size, but Mitchell (1975) suggests that their apparent rarity may be due to earlier unrecorded exploitation by whaling ships as practice targets, though this view has been criticised (NCC 1980). Currently they are taken in small numbers in Japan, and possibly in Indonesia (Mitchell 1975). Handley (1966) states that they feed on squids, crabs and shrimps, and Fitch and Brownell (1968) add some fish also. The fact that this species feeds mainly on squid, is not particularly common, and travels in small groups of 3 - 6, or alone (Mitchell 1975) might suggest that interactions with fisheries are unlikely, but some gear conflicts have been reported (see area 61).

21 27 31 34 (41) 47 51 57 61 71 77 81 87

Kogia simus Owen, 1866 Dwarf sperm whale
This species was for a long time confused with the previous one (Handley 1966), and so there is little exclusive information pertaining to it (Mitchell 1975). Handley states that it has been found in South Africa, India, Sri Lanka, Japan, Hawaii, South Australia, and eastern USA Leatherwood and Reeves (1983) add California and Guam. Like the previous species it must be considered uncommon and no population estimates are possible. Leatherwood and Reeves (1983) suggest that it may prefer the edge of the continental shelf. Fitch and Brownell (1968) found that deep water fish supplement the main diet of squid. Again, interactions seem to be limited to occasional gear conflicts (see area 61).

31 (34) (41) (47) 51 57 61 (71) 77 (87)

MONODONTIDAE

Monodon monoceros Linnaeus, 1758 Narwhal
Tomilin (1967) states that this species is confined to the Arctic Ocean, north of the 'drifting ice boundary'; Mitchell (1975) adds that it is absent from the north Siberian shelf and rare in the north Alaskan sector. Hershkovitz (1966) reports its presence as far south as the Bering Sea in the Pacific region and the Netherlands in the Atlantic. These must represent extremes however. There are no population estimates for the species as a whole, but Mitchell (1975) records a 'conservative' estimate of the northern Canadian and northwestern Greenland stock to be around 10 000. Tomilin states that the species has been severely reduced in the region around Novaya Zemlya and Franz Josef Land. The diet according to Tomilin is made up from squids in the main, but also some fish including skate, flounder, halibut, cod, salmon and herring. Meldagaard and Kapel (1981) found that Boreogadus saida, the Arctic cod, predominated in one stomach they examined, whilst Finley and Gibb (1982) found Boreogadus and several other species including Arctogadus sp., Rheinhardtius hippoglossoides and Gonatus fabricii in their samples. This species is hunted in and around eastern Canada and western Greenland. No direct interaction with fisheries is known at present.

18 21 27 61 67

Delphinapterus leucas (Pallas, 1776) White whale
Tomilin (1967) describes the white whale as widespread in cold waters, adding that it

stays in the coastal zone. Gurevich (1980) provides a useful review of this species and gives details of distribution and diet. The southerly limits to distribution are France and New York in the Atlantic, and the Sea of Japan and the Gulf of Alaska in the Pacific. The diet consists largely of fish, and Gurevich provides a comprehensive list of these; they include Arctogadus glacialis, Mallotus villosus, Ammodytes spp. and various other small fish, as well as a variety of flatfish and some more commercially valuable fish, such as salmon and haddock. Gurevich states that no other small whale has such a varied diet, but that they usually feed on small fish, crustaceans and benthic animals such as molluscs and polychaete worms, adding that they may be unable to swallow large fish and that deep water organisms are entirely absent from the diet. Mitchell (1975) lists a possible 9 separate stocks. Sergeant and Brodie (1975) have estimated the North American population as around 30 000 or more individuals. The report of the Sub-Committee on Small Cetaceans (IWC 1982) gives figures of 232 and 1 570 as minimum and maximum counts of white whales in the Barents, Kara and White Seas. The varied diet of the white whales probably safeguards it from any immediate threat to its food supply, but the fact that its diet includes commercial fish species may not protect it from some criticism at least (see area 27). White whales have been involved in incidental catches and mortalities in fishing operations (see areas 21 and 67), and they have also been hunted over their entire range (Mitchell 1975).

18 21 27 61 67

DELPHINIDAE

Steno bredanensis (Lesson, 1828) Rough-toothed dolphin
Hershkovitz (1966) gives the distribution of this species in the Atlantic from the Netherlands and Virginia in the north, to the coast of Argentina and to north east of Tristan da Cunha. In the Pacific it is recorded from California, Japan, and the Galapagos Islands, and in the Indian Ocean from South Africa to Aden and Indonesia. Mitchell (1975) also records its presence in small numbers in the Mediterranean. There are no population estimates, but Leatherwood and Reeves (1983) suggest that they are widely distributed without being known to be numerous in any particular area, and prefer deep waters far offshore. Perrin and Watkin (1975) found fish and molluscs in stomachs of animals from the Pacific, and Layne (1965) recorded pelagic octopus in Florida, otherwise there is little information on feeding. This species has been caught in tuna nets (see area 77) and is sometimes deliberately taken in the St Vincent small whale fishery (see area 31) as well as in Japan both deliberately and incidentally (see area 61). There appears to be no major problem for either the species or fishermen with this degree of interaction however.

21 27 31 34 37 41 47 51 57 61 71 77

Sotalia fluviatilis (Gervais, 1853) Tucuxi
Hershkovitz (1966) recognised 3 separate species, though these are currently considered to be conspecific. The distribution of the three forms is, according to Hershkovitz, throughout the Amazon river and in the lower parts of its tributaries, along the coasts and in the rivers of Venezuala and the Guianas, and along the coast of Brazil, possibly as far as Sao Paulo, but with certainty only in the Baia de Rio de Janeiro. Mitchell (1975a) states that it occurs all along the South American coast from Lake Maracaibo to Santos in Brazil. There are no population estimates of this species. Mitchell (1975a) states that they eat armoured catfish and some crabs and prawns. Leatherwood and Reeves (1983) state that shoaling fish are also eaten in the central Amazon. Mitchell (1975a) and Leatherwood and Reeves (1983) both refer to catches along the coasts of Brazil and Surinam in gill nets around river mouths (see areas 31, 41).

31 41

Sousa chinensis (Osbeck, 1765) Indo-Pacific hump-backed dolphin
This species was previously thought of as 4 separate species (NCC 1980). The distribution is from near the Cape of Good Hope around the East African coast to the Red Sea, through the Indonesian archipelago, to Australia, Sydney on the east and Carnarvon on the west, and up to the Canton River in China (Mitchell 1975). Mitchell also states that data on

feeding is lacking, but says that they eat fish. Saayman and Taylor (1973) describe their feeding behaviour as solitary and dispersed, feeding in rocky areas and reefs, often near breaking waves. They have been caught in nets incidentally along the African and Australian coasts (see areas 51 and 57), but elsewhere apparently remain uninvolved with fisheries, perhaps surprising for a coastal species.

47 51 57 61 71

Sousa teuszii (Kukenthal, 1892) Atlantic hump-backed dolphin
Mitchell (1975) states that its presumed range is along the West African coast from Mauritania in the north to Angola in the south and that the only information on the population size is that it is rather common in the coastal waters of Senegal. Busnel (1973) describes the way fishermen in Mauritania use the dolphins feeding behaviour to catch mullet, which the dolphins also eat (see area 34). Cadanet (1956, 1957, 1959) also reports some taken in shark nets. These are the only records of interaction with fisheries.

34 47

Orcaella brevirostris (Gray, 1866) Irrawaddy dolphin
Distributed in coastal waters, estuaries and rivers of the Indian ocean and South China Sea from North Borneo (Sabah) to the Bay of Bengal and up the Mekong, Ganges and Irrawaddy rivers (Hershkovitz 1966). Also found in northern Australian waters and in Papua New Guinea (Mitchell 1975). There is little data on feeding, beyond Mitchell's (1975) suggestion that the species feeds on fish as well as crustaceans, and no information on the size of the population. There have been a few instances of interaction with fisheries (see areas 57 71).

57 71

Peponocephala electra (Gray, 1846) Melon-headed whale
Distributed throughout tropical seas north of 10°S, but apparently unknown from South American waters, and with few records in the Atlantic. There are no estimates of the population size, but it does not seem to be particularly rare, especially in the Pacific, and may normally be distributed away from land masses (NCC 1980). There is no data on feeding. This species has been caught, infrequently, in tuna nets, (see area 77) and has been caught deliberately and incidentally elsewhere (see area 61 31). This has probably had little effect on the population.

31 34 41 47 51 57 61 71 77

Feresa attenuata Gray, 1875 Pygmy killer whale
Caldwell and Caldwell (1971) chart the records of this species until 1971. It is recorded, infrequently, from warm waters worldwide: Caribbean, Senegal, South Africa, Japan, and the tropical Pacific. Racey and Nicoll (1982 in press) cited by Keller et al (1982) also record it around the Seychelles, thereby confirming its worldwide distribution. It has been taken in some small whale fisheries, in Japan (Nishiwaki et al 1965), and in St Vincent (Caldwell & Caldwell, 1975). Pryor et al (1965) report that a specimen in captivity in Hawaii ate mackerel, squid, and other fish, as much as 12 lbs per day, whereas Nishiwaki et al (1965) reported that their specimen rejected squid, saurie and mackerel-pike, but accepted sardines. The data on feeding is therefore somewhat confused. There is no information on the population status of this species: the paucity of records may indicate that it is very rare (NCC 1980), yet Pryor et al reported seeing one school of about 50 individuals. They have been taken accidentally in fishing nets (see area 77), but the infrequency of their occurrence makes such conflicts unlikely to affect their population dynamics, unless whole schools are taken.

31 34 47 51 (57) 61 71 77 (87)

Pseudorca crassidens (Owen, 1846) False killer whale
Widely distributed throughout warm and temperate waters, from the North and Baltic Seas and the Davis Straits, to South Africa and Patagonia in the Atlantic; from the Bering Sea to Chatham Island, Tasmania and New Zealand in the Pacific and also in the Indian Ocean

(Tomilin, 1967). Tomilin also states that this species is usually pelagic, inshore movements are usually associated with those of squid, and that the diet includes fish as well as squid. The false killer whale seems to be fairly common, though there are no assessments of the population. It is also subject to occasional directed fishing in both Japan (Miyazaki 1983) and St Vincent (Caldwell et al 1971a). Several conflicts with fisheries are known (see areas 57 61 71 77), and it seems likely that the distribution and feeding habits of this gregarious species could mean that more instances of such conflicts may become known. Mitchell (1975), for example, states that the species "damages fish on longlines, worldwide".

21 27 31 34 37 41 47 51 57 61 71 77 81 87

Orcinus orca (Linnaeus, 1758) Killer whale
Tomilin (1967) states that the killer whale is a cosmopolitan species found in coastal and oceanic regions from Arctic to Antarctica, though not in the Laptev nor East Siberian Seas. Mitchell (1975) suggests that abundance is greatest within 800 km of the shore in cold waters of both hemispheres.

Dahlheim (1981) states that there are no population estimates available on a worldwide basis, and reviews the biology and exploitation of the species. Hammond (1983) estimates that there are more than 160 000 in Antarctic areas II III IV and V. They have been hunted in many areas of the world (see Mitchell 1975a, Dahlheim 1981), and a few are still taken by Korea, Norway, Japan and also by Iceland for display (IWC 1983 p168). Descriptions of diet vary with author and location, and notwithstanding Gurevich's (1980) contentions relating to the white whale (see above: Delphinapterus leucas), the killer whale seems to consume a more varied diet than any other cetacean. A review of information on diet is presented by the report of the Killer Whale Workshop (IWC 1982 p628-629). A large number of marine mammal species have been recorded as well as fish and squid. Authors vary as to which groups are most important. The consumption of commercial fish, however is widespread and has led to one of the greatest number of interactions between fisheries and any species of marine mammal (see for example Mitchell 1975a). These are mentioned under sections dealing with areas: 27 34 41 51 57 61 71. Despite this and despite the fact that they are frequently shot at by fishermen throughout their range (e.g. Mitchell 1975a, Goodall and Cameron 1980), there does not seem to be any particular threat to this species, probably due to its relative abundance and catholic diet which precludes a depletion of its food supply.

18 21 27 31 34 37 41 47 48 51 57 58 61 67 71 77 81 87 88

Globicephala melaena (Traill, 1809) Long-finned pilot whale
Found in the North Atlantic from the Barents Sea, Iceland and Greenland, south as far as Cape Hatteras on the east and the Mediterranean on the west (NCC 1980). Apparently absent from the North Pacific at present, it seems to have existed there at one stage, its disappearance remaining a mystery (Kasuya 1975). This same species also exists in the southern hemisphere (Van Bree 1971), from north of the Antarctic convergence in the cold Humboldt, Benguela and Falkland currents (Mitchell 1975). There are no population estimates but Mitchell (1973) believes that the stock around Newfoundland had been depleted due to overexploitation. This species has been subject to a number of hunts and is still taken in the Faroes (IWC 1983 p168). Sergeant (1962) found that the diet in Canada consisted almost entirely of squid (Illex illecebrosus), and cod when this was scarce. Mitchell (1975) also reports another squid, Ommastrephes saggitatus and some fish including the horse mackerel Caranx trachurus and flatfish in stomachs of animals from Britain. Mercer (1967) found the Greenland turbot Rheinhardtius hippoglossoides as a food item in the western North Atlantic in winter. A number of incidental catches have been recorded (see areas 21 27 37).

21 27 (34) 37 41 47 81 87

Globicephala macrorhynchus Gray, 1846 Short-finned pilot whale
Occurring in all tropical and warm waters of the world, this species appears to be allopatric with the previous one. In the Atlantic it ranges as far north as Cape Hatteras, Mauritania and Madeira, south to Angola on the east and possibly around the same latitude in Brazil on the west. It probably occurs throughout the Indian Ocean, and

from Peru to the Gulf of Alaska, from Japan to northern Australia in the Pacific (Mitchell 1975). There are no population estimates available, but Mitchell (1975) suggests that the Japanese stock may have been depleted due to overexploitation. A few hundred are still taken in Japan, (IWC 1983 p.168) and some may be taken in the Caribbean (Caldwell et al 1971a).

Kritzler (1952) found that 3 animals had squid in their stomachs and that a fourth kept in captivity ate only squid for some time, eating 20lbs per day. Later it took fish and also grew, eating 45lbs of food per day. He reports that it had difficulty in digesting herring and suggests that the absence of a gall bladder may mean that the species needs lots of fatty food. Some are known to be caught incidentally in Japan (see area 61) but otherwise this species does not seem to interact much with fisheries (see also area 77).

27 31 34 41 47 51 57 61 67 71 77

Lagenorhynchus albirostris (Gray, 1846) White-beaked dolphin
Confined to the North Atlantic from Davis Strait to Massachusetts, and from Iceland and Norway through the Baltic and North Sea to France (Sergeant and Ficher 1957). Tomilin (1967) adds that it is most common in the North Sea, especially the northern part. There are no population estimates, but Mitchell (1975) refers to it as 'fairly abundant'. The diet consists of fish, (Clupea harengus, Gadus morhua, Merlangius merlangius, Eleginus navaga,), some crustaceans, and some molluscs including cephalopods (Tomilin). There is possibly some by-catch in Iceland (Mitchell 1975a).

21 27

Lagenorhynchus acutus (Gray, 1828) Atlantic white-sided dolphin
As with L. albirostris this species is confined to the North Atlantic. Tomilin (1967) states that it occurs as far north as Spitzbergen and Greenland in coastal waters. Testaverde & Mead (1980) have extended the known southern occurrence of this species in the USA to Chesapeake Bay. Marcuzzi and Pilleri (1971) give the southern limits of its distribution on the eastern side of the Atlantic as the Mediterranean. Mitchell (1975) describes it as abundant at least near Newfoundland and Norway. The diet is said to consist largely of squid and herring (Sergeant & Fisher 1957), whilst Tomilin suggests mackerel and salmonids too, and also relates that vast numbers are known to enter Norwegian fiords chasing herring.

21 27 37

Lagenorhynchus obscurus (Gray, 1828) Dusky dolphin
Mitchell (1975) descibes this as an inshore species with an apparent circumpolar distribution in temperate and cooler waters of South America, South Africa, New Zealand, southern Australia and Kerguelen Island. Mitchell (1975) states that there is no information on the status of the population of this species. As regards diet, Watson (1981) states that they eat 'fish and squid', but there appears to be little more information than this. Dusky dolphins are known to be caught incidentally in a number of fisheries (see areas 41 47 87)

41 47 51 57 81 87

Lagenorhynchus cruciger (Quoy & Gaimard, 1824) Hourglass dolphin
There is very little information on this species. Brownell (1974) gives its distribution as pelagic circumpolar in the southern hemisphere, both sides of the Antarctic convergence, but confined to cold water. Watson (1981) describes the species as apparently relatively common in cold southern waters and reports seeing them eating fairly large fish on the surface. There are no reports of interactions with fisheries.

41 47 48 51 (57) (58) 81 87 88

Lagenorhynchus australis (Peale, 1848) Peale's dolphin
Confined to the coastal zone around southern South America and the Falkland Islands. Nothing is known of the status of the population, and the only information on food is that one specimen had octopus in its stomach, (Mitchell 1975). There has been some

operational conflict in southern Argentina and Chile with local fishermen which may represent a threat to the population (see areas 41, 87).

41 87

Lagenorhynchus obliquidens Gill, 1865 Pacific white-sided dolphin
Confined to the coastal waters of the North Pacific, from the Bering Sea to California and Japan (Mitchell 1975). Tomilin (1967) states that it eats small gregarious fish such as sardines, herring, salmon, anchovies, saury and jack mackerel, and cephalopod molluscs such as Ommastrephes pacificus. Fitch and Brownell (1968) added the hake Merluccius productus to this list. Mitchell (1975) cites Nishiwaki (1972) who estimates the population in the northwest Pacific to be between 30 and 50 thousand. There are some records of incidental catches of this species (see area 61) as well as the directed Japanese catch of around 250 (IWC 1983 p 168).

61 67 77

Lagenodelphis hosei Fraser, 1956 Fraser's dolphin
Until 1973 there was only one record of this species, from Sarawak. Perrin et al (1973a) reported 5 or 6 new records of the species which has since been recorded a number of times again. Perrin et al suggest a continuous distribution of the species on the high seas of the Indian and Pacific oceans. It has since been recorded in the Atlantic too (Caldwell et al 1976), where it has turned up in the St. Vincent small whale fishery. The only population estimate available is for the eastern tropical Pacific where 7800 animals are estimated to be involved in the tuna seine fishery. Tobayama et al (cited in, NCC 1980) have found deep-sea fish and squid in stomachs. Robinson and Craddock (1983) found mesopelagic fish. Leatherwood and Reeves (1983) state that these items as well as crustaceans are eaten at night when they rise to the surface. The only known interactions with fisheries are in the eastern tropical Pacific tuna fishery and in Japan (see areas 61, 77).

31 (34) (41) (47) 51 57 61 71 77

Tursiops truncatus (Montagu, 1821) Bottlenose dolphin
Mitchell (1975) states that distribution is worldwide in temperate to tropical waters, and that the species is mainly coastal but that it may occur far offshore in some areas. There are no overall population estimates, but in some areas the size or status of local stocks has been estimated. Diet varies considerably, but Tomilin describes the species as 'benthoichthyophagous', or feeding on bottom fish of the neritic zone, and goes on to suggest that feeding on pelagic fish only occurs where these are in dense enough shoals. Feeding on pelagic fish has been described in Florida by Hoglund (1965). There have been a number of fisheries for this species notably in the eastern U.S.A. and the Black Sea, but exploitation at present is restricted to a few hundred in Japan and possibly a few elsewhere (IWC 1983 p168). This species is involved in a great number of interactions with fisheries, mostly incidental catches, largely because it feeds in much the same area and often on many of the same fish species as are fished by fisheries (see areas 27 31 37 41 51 57 61 71 77 81 87). No doubt many more are killed in coastal drift nets and beach seines than are recorded so far.

21 27 31 34 37 41 47 51 57 61 71 77 81 87

Grampus griseus (G. Cuvier, 1812) Risso's dolphin
Tomilin (1967) describes this species as rare but widespread in warm and temperate waters of the northern and southern hemispheres. Mitchell (1975) adds that it is generally found in waters deeper than 180 metres, and from Sweden and Newfoundland south to Argentina and South Africa in the Atlantic. The distribution in the Pacific he describes as from the Kurils and British Columbia to Peru and New Zealand, and probably throughout the Indo-Pacific region. Both of these authors agree that Risso's dolphin feeds on squid. There is no information on the status or number of any stocks (Mitchell 1975). There are a few still taken in small whale fisheries in Japan and the Caribbean (Miyazaki 1983, Caldwell et al 1971a) but these probably amount to less than 30 per year (IWC 1983 p168). There are also however a few reports of incidental catches of this species in some areas (see areas 27 37 61 77). It is unlikely that any other form of interaction could develop in

the absence of intensive squid fisheries.

21 27 31 34 37 41 47 51 57 61 67 71 77 81 87

Stenella longirostris (Gray, 1828) Spinner dolphin
Mitchell (1975) describes the distribution of these dolphins as throughout all tropical seas. This species is one of those involved in the tuna seining operations of the eastern tropical Pacific, and as such its population may have been severely affected. In 1978 the total population of two stocks there was estimated at around 2 million animals (IWC 1978 p81), but there are no reliable estimates either for the whole of area 77 nor for the rest of the world. Currently (1981) between 7 and 10 000 animals are taken in seining operations (IWC 1983 p 168). Perrin et al (1973a) report that spinner dolphins feed on mesopelagic fish and epipelagic and mesopelagic squids. A number of other interactions with fisheries have been reported from around the world, though none of these is likely to be of the same magnitude as the tuna seining in the ETP (see areas 31 34 51 57 61 71).

31 34 41 47 51 57 61 71 77 87

Stenella coeruleoalba (Meyen, 1833) Striped dolphin
Occurring from southern Greenland and the North Sea to Rio de la Plata in Argentina and southern African seas in the Atlantic; from the Bering Sea and Siberian waters to California and to New Zealand in the Pacific (Hershkovitz 1966). Watson (1981) also reports seeing large numbers in the Indian Ocean and Leatherwood and Reeves (1983) describe this as the most common cetacean species in the Mediterranean. Again there are few reliable population estimates for this species although there are some in areas where they are caught accidentally or deliberately. Nishiwaki (1975) estimates the Japanese population at between 0.4 and 0.6 million animals and claims that the catch at that time of around 20 000 per year in drive fisheries was not affecting the population. Currently the 'drive-catch' in Japan is less than 5 000 per year (IWC 1983 p168). In the ETP it was estimated in 1978 that there were around 250 000 animals (IWC 1978 p81), but the catch there was never as large as for other species, and is currently only around 60 animals per year, so it may be presumed that the population is not greatly reduced. Miyazaki et al (1973) found that the main food of striped dolphins is small mesopelagic fish, with some squid and shrimp. There are a number of other interactions between this species and fisheries which have been reported, but these are all incidental catches (see areas 27 37 61 77); the diet of this species, which does not seem to include any major commercial species at present is unlikely to bring it into any closer contact with fishing interests.

21 27 31 34 37 41 47 51 57 61 67 71 77 81

Stenella attenuata (Gray, 1846))
Stenella dubia (G. Cuvier, 1812)) Spotted dolphins
Stenella frontalis (G. Cuvier, 1829)) (2 species)
Stenella plagiodon (Cope, 1866))

There are probably only 2 species amongst these nominal 4 (Mitchell 1975). S. attenuata occurs in the Atlantic, Pacific and Indian Oceans, whilst the other 3 species are confined to the Atlantic. S. attenuata occurs in both coastal and offshore waters of tropical seas, whereas the range of the species group in the Atlantic extends into warm temperate waters (Mitchell 1975). S. attenuata was the species most affected by the ETP tuna seine fishery. There were estimated to be more than 3 million in 1978 (IWC 1978 p 81), with over 150 000 being killed per year in the early 1970's (Mitchell 1975). The number being killed has dropped now to around 25-30 000 per year in the ETP. There is also a small fishery in Japan (IWC 1983 p 168).

There are no other estimates of population size or status for any other stocks of any of the species group. Spotted dolphins associated with tuna in the ETP have been shown to feed on epipelagic fish and epipelagic and mesopelagic squids (Perrin et al 1973a). A number of animals are caught incidentally around the world in different types of fishery (see areas 31 57 61 71 77), but there is always the possibility that large mortalities of these species may recur if dolphin associated tuna fishing is expanded in other areas of the world outside the ETP (see e.g. Caldwell & Caldwell 1971). As surface feeding and

frequently coastal feeders, these species are also always open to incidental capture by a number of types of fishery.

31 34 41 47 51 57 61 71 77 87

Stenella clymene (Gray, 1846) Clymene dolphin
Only recently recognised as a valid species, this dolphin is confined to the warm waters of the Atlantic, from New Jersey to the Caribbean and across the tropical Atlantic to West Africa. There are no data on the population size, but the diet is thought to include small mesopelagic fish, especially myctophids (Perrin et al 1981). There are no reported interactions with fisheries yet, but this may be due to the fact that this species has only recently been re-discovered.

31 34

Delphinus delphis Linnaeus, 1758 Common dolphin
Worldwide in distribution, this species occurs from Newfoundland, Iceland and Norway to Argentina and South Africa in the Atlantic; Japan and California to New Zealand and Tierra del Fuego in the Pacific and in the Indian Ocean (Hershkovitz 1966, Goodall 1977, Leatherwood and Reeves, 1983). Tomilin (1967) states that it is most numerous in the temperate waters of the northern hemisphere, but may occur in schools of thousands in the tropics. Estimates of population size are lacking, except in the ETP where a population of at least 1.5 million is estimated (IWC 1978 p 81), (see area 77). Current world catches exceed 8 000 per year (IWC 1983 p 168). Diet varies with location. Tomilin says they eat sprats, sardines and anchovies on the French coast and in the Black Sea, but also lists numerous other species which they are known to take in the Black Sea. Watson (1981) states that they eat mesopelagic fish and squid in the scattering layer. The diet is clearly fairly varied, though mostly of small animals. There are a number of recorded interactions with fisheries around the world (see areas 27 34 37 41 47 51 61 77 81).

21 27 31 34 37 41 47 51 57 61 71 77 81 87

Lissodelphis peronii (Lacepede, 1804) Southern right whale dolphin
Distributed around the southern hemisphere north of the Antarctic convergence and in cold currents as far north as Peru, South Africa and New Zealand (Brownell 1974). Brown (1982) and Cruickshank and Brown (1981) provide descriptions of the known distribution of the species, as well as information on other aspects of the biology. There are no estimates of the population size. Cruickshank and Brown state that the food is thought to be myctophids and squid. There is one record of interaction with fisheries (see area 87). The inaccessability of the species' habitat, and its diet of non-commercial species make any further interactions unlikely.

41 47 48 51 57 58 81 87 88

Lissodelphis borealis (Peale, 1848) Northern right whale dolphin
Tomilin (1967) describes the range as from California and Japan to the Bering Sea. Mitchell (1975) says that it prefers cooler offshore waters. There are no estimates of abundance. Fitch and Brownell (1968) recorded squid and lantern fish (Myctophidae) remains in a sampled stomach. Relatively little is known of this species, like the previous one. There are a few taken incidentally and/or deliberately by Japanese fishermen (see area 61).

61 67 77

Cephalorhynchus heavisidii (Gray, 1828) Heaviside's dolphin
Confined to the coastal seas of South Africa, from Cape Town northwards along the Atlantic coast to Cape Cross (Mitchell 1975). Nothing is known of the status of the population. The diet is suggested to consist of squid and bottom dwelling fish (Mitchell 1975). This species is known to be caught incidentally in a number of fisheries (see area 47).

47

Cephalorhynchus eutropia (Gray, 1846) Black dolphin
Distributed along the coast of Chile from around Concepcion to Tierra del Fuego at least (Aguayo 1975, Goodall 1977). Although nothing is known of the status of this species, Aguayo maintains that it is the rarest of the genus. There appears to be no detailed data on feeding. There is known to be some incidental catch of this species, but the size and effect of this catch have not been determined (see area 41 87).

41 87

Cephalorhynchus hectori (van Beneden, 1881) Hector's dolphin
Found only around the islands of New Zealand in coastal waters (Mitchell 1975), Baker (1978) states that it is often found in muddy waters, less than 8 km from shore, and is commonest in the central eastern part of New Zealand. The status of the species is unknown, but it has been suggested both that it is in decline and that the population is stable (Baker 1978). Again according to Baker, the food consists of pelagic and benthic fish from below the surf zone, including Physiculus bachus the red cod, stargazers and anchovies. Some are known to be taken incidentally in gill net and trawl fisheries of the area.

81

Cephalorhynchus commersonii (Lacepede, 1804) Commerson's dolphin
Brownell (1974) describes the distribution of this species which appears to have a range extending from around Kerguelen Island, South Georgia, the Falklands/Malvinas and the coast of Argentina from Peninsula Valdez to Tierra del Fuego. It is not clear to what extent these populations are isolated from one another. There is no information on the status of this animal, yet Goodall and Cameron (1980) report it around Tierra del Fuego in such numbers that it may be quite common. This species is also taken incidentally by fisheries in Tierra del Fuego (see areas 41 87).

41 48 58 87

PHOCOENIDAE

Phocoena phocoena (Linnaeus, 1758) Harbour porpoise
Gaskin (1983) has presented a detailed account of the apparent distribution and status of regional populations of this species; he describes the distribution as more or less circumpolar in temperate waters of the northern hemisphere. Reporting various authors' findings, Gaskin gives a northerly limit for the distribution of the species in the Pacific region as the Mackenzie River delta in northern Alaska, and the Chukot Peninsula in the Chukchi Sea. It is apparently rare in the waters of Japan, this, Gaskin suggests, may be the result of over-exploitation, but is frequently found as far south as Monterey in California on the other side of the Pacific. In the northwest Atlantic the harbour porpoise is found as far north as about 70°N in the Davis Strait on the Greenland side, though not apparently this far north on the Canadian side and not in the Hudson Bay. It is said to be common around Iceland and Norway, extending as far north as the White Sea. The southerly limit of the range is about 34°N on the western side of the Atlantic and Senegal and the Cape Verde Islands on the east. A population exists in the Black Sea, considerably reduced by exploitation, but the presence of a population in the Mediterranean is questionable. Gaskin suggests that the number of animals in European Atlantic waters, the Baltic and possibly the North Sea have declined in recent years, for unknown reasons, although it is still common in both Norway and the Azores. The diet of the harbour porpoise has been summarised by Gaskin et al (1974) and includes a large number of fish species, which Mitchell (1975) describes as 'mainly smooth, non-spiny fish especially gadoids and clupeoids'. The harbour porpoise is also regularly taken incidentally, often in quite large numbers, throughout most of its range (see areas 21 27 61 67 77)

18 21 27 34 37 61 67 77

Phocoena sinus Norris and McFarland, 1958 Cochito
Restricted to the Gulf of California in Mexico, and more abundant in the northern part of the Gulf (Mitchell 1975). This is not a particularly numerous species though no popula-

tion estimate is available. The diet is known to include striped grunts Orthopristis reddingi, and gulf croakers Bairdiella icistius, as well as squid (Brownell 1983). Between 10 and 100 are taken accidentally in gill nets per year (see area 77), and this according to Brownell, may represent a substantial impact on a local and relatively small population.

77

Phocoena spinipinnis Burmeister, 1865 Burmeister's porpoise
Distributed around the coast of southern South America, from Punta del Diabolo in Uruguay (Pilleri & Gihr 1972) to Tierra del Fuego (Goodall 1977) and up the coasts of Chile and Peru to around 5°S (Aguayo 1975). It has been considered as possibly the most numerous small cetacean in this area (Brownell and Praderi 1982), but there are no estimates of the size of the population. The diet is known to include Merluccius hubbsi, Pagrus sedecim and squid (Brownell and Praderi 1982). This species is taken in large numbers both accidentally and deliberately, particularly off Peru (see areas 41 87), but the effect of this catch on the population is not known.

41 87

Phocoena dioptrica Lahille, 1912 Spectacled porpoise
Known only from only a few individuals and originally thought to be confined to the South West Atlantic (Brownell 1974), this species has since turned up in New Zealand (Baker 1977) and possibly in the Indian Ocean off South Africa (Frost and Best 1976). In the South Atlantic it is known from Tierra del Fuego (Goodall 1977) as well as the Falklands, South Georgia and Uruguay (Brownell 1975a). It is not clear whether these populations are isolated from one another, and there is no information on the status of the species, though the number of times it has been recorded (about 15) indicates that it may not be very common. There is nothing known of the food habits either. Some are known to be taken in Argentinian tangle nets (see area 41).

41 48 51 81

Phocoenoides dalli (True, 1885) Dall's porpoise
Common in inshore cold waters of the North Pacific, but also found out to about 500 miles, this species ranges from Baja California around the North Pacific via Alaska, the Bering Sea, Sea of Okhotsk and eastern Sea of Japan to Honshu (Mitchell 1975). Bouchet (1983) estimates the population in the North Pacific and Bering Sea to be between 790 000 and 1 738 000 by a strip-transect method. Wilke and Nicholson (1958) found myctophid lantern fish and squids to be the most important food items in the diet. This species is taken in large numbers by the salmon gill net fishery (see areas 61 and 67), but the effect of this on the population is unclear.

61 67 77

Neophocoena phocaenoides (Cuvier, 1829) Finless porpoise
A coastal and riverine species found in the major rivers and around the coasts of the region bounded by the Arabian Peninsula, Indonesia, and Japan, and including Oman, Pakistan, India the Philippines and China as well as most other countries in the region. There is also some dispute as to whether its range extends to South Africa (NCC 1980). Baker (1972) suggests that it may occur as far south as New Zealand. There is no information on the overall population size, but the numbers around Japan have been estimated at between 1 600 and 4 900 (Kasuya and Kureha 1979, cited in NCC 1980), and may be common in other parts of its range (NCC 1980). The diet is said to consist of small squids and cuttlefish, crustaceans and some small fish such as sandlance (Mitchell 1975). There is some reported interaction with fisheries in Japan, Australia and the Indo-Pakistan coast (see areas 51 61).

51 57 61 71

PLATANISTIDAE

Platanista gangetica (Roxburgh, 1801) Ganges susu
Mitchell (1975) describes the distribution of this species as "throughout the Brahmaputra and Ganges river systems". Its range extends up to the Himalayas, to Nepal and possibly Bhutan, and down to the estuaries in Bangladesh and India (NCC 1980). The total population has been estimated at around 4 - 5 000, with the population in the Ganges having declined (Jones 1982). The food species are unknown, but said by Mitchell (1975) to be probably fish and shrimps. This species is known to get caught in nets of river fishermen (see area 57), but the extent of this is unknown.

57

Platanista minor Owen, (1854) Indus susu
Confined mainly to the lower reaches of the Indus River in Pakistan, the range used to cover the entire river system to the foothills of the Himalayas (NCC 1980). The population is now isolated into a number of groups by the building of barrages along the river (Mitchell 1975a). Kasuya and Nishiwaki (1975) have estimated the population at between 450 and 600, with a decline of 10% per year at that time. The food of this species is unknown, but Pilleri's (1972) specimens ate between 1 - 1.4 kg of fish per day. They are still apparently killed in nets of fishermen (see area 51).

51

Inia geoffrensis (de Blainville, 1817) Boutu
Found throughout the Amazon and Orinoco river systems in South America, including the tributaries upstream in Bolivia (Mitchell 1975). Traditionally the species was given some superstitious protection from such hunting. Mitchell states that the stocks of this species might be near original levels but Leatherwood and Reeves (1983) state that increased numbers of this dolphin are being killed by settlers in the Amazon region, who are not inhibited by traditional taboos. Food is known to consist of characins and catfish, as well as crustaceans (Mitchell, Leatherwood and Reeves). There are also known to be some mortalities of this species in gill nets, and it has been claimed that the species cooperates with fishermen (see areas 41 31).

31 41

Lipotes vexillifer Miller, 1918 Beiji
Pei-Xun (1981) provides an account of this little studied species. It is confined to the middle and lower reaches of the Chianjiang River in China. The population is said to be small, with only one animal seen per 10 km. Pei-Xun describes it as rare. Brownell and Herald (1972) describe the contents of one stomach as being catfish, but there is little more information than this concerning the diet. The species is thought to be declining due in part at least to the conflict with local fisheries (see area 61).

61

Pontoporia blainvillei (Gervais & d'Orbigny, 1844) Franciscana
A coastal species ranging from the Peninsula Valdez in Argentina to the tropic of Capricorn in Brazil (NCC 1980), extending out as far as the 20 fathom curve (Leatherwood and Reeves, 1983). There are no estimates of abundance available. The food is described in detail by Brownell and Praderi (1976) and includes the species Engraulis anchoita, Cynoscion striatus, Trachurus lathami, Porichthys lathamis, and other Anchoa species. There is some by-catch by a local shark fishery which may have a significant effect on the Franciscana population (see area 41)

41

2.2 PINNIPEDIA

OTARIIDAE

Eumatopias jubatus (Schreber, 1776) Steller sea lion
Distributed around the edges of the North Pacific from the Sea of Japan northwards to around 66° North, and then south around the coast of the USA and Canada to San Miguel Island, California. The total population is estimated to be around or in excess of 230 000, the bulk of which population (200 000) is found in Alaskan waters. The population in southerly areas is smaller and may be declining as the population recedes northward (Mate and Gentry, 1979). Approximately 15 000 animals are killed in Alaska, Japan and the USSR, mostly in fishing operations (Mate 1982a). The diet is said to consist mostly of non-commercial fish species and cephalopods, but may also include some commercial species such as salmon (Fiscus & Baines, 1966). Wilke and Kenyon (1952) also found small gadids, flatfish and sandlance in 2 stomachs they examined. Schusterman (1981) cites Keyes' (1968) review of feeding date for this species and includes flounder, halibut, cod, pollock, smelt and greenling. Schusterman also cites Mathison et al (1962) who found that 27% of the diet was fish, 35% cephalopods, 20% bivalves and 8% shrimps and crabs. Some conflict is known between this species and fishermen (see areas 61 67 77).

61 67 77

Zalophus californianus (Lesson, 1828) California sea lion
According to Mate (1979) there are three breeding sub-populations of this species. The northerly limit of the range of the Californian/Mexican population is British Columbia (51°N), which is reached by post breeding males. The limit of the breeding season range is around 34°N, and some males apparently also migrate south as far as Manzanillo in Mexico (19°N). The Galapagos group breeds in and inhabits the area around the Galapagos Islands, and the third group, which bred in the Sea of Japan may be extinct. This species is also known to exist in small numbers on the eastern seaboard of the USA, having escaped from captivity, but apparently has not yet bred there (Caldwell et al 1971). Mate (1982) indicates a total Californian/Mexican population of around 75 - 100 000 animals, and a Galapagos population of around 20 000; the former, after some quite heavy exploitation last century may now be increasing and expanding its range northwards. He also describes this species as a shallow water opportunistic feeder, whose main foods are thought to be squid, including Loligo, and small fish such as Engraulis, Merluccius, Clupea, and various small rock fish. Bailey and Ainley (1982) have confirmed the importance of Merluccius productus in the diet. There are a number of known interactions between this species and commercial fisheries in the California region (see areas 67 and 77).

31 (61) 67 77

Otaria flavescens (Blainville, 1820) South American sea lion
Distributed around the coasts of South America from around 23°S on the Brazilian coast southwards to Tierra del Fuego, and then north to around 4°S on the coast of Peru (Scheffer 1958). The total population has been estimated from various authors to be around 273 000 animals (Vaz-Ferreira 1979), 2/3 of this total being in Argentinian waters. The population structure has changed historically, having decreased in some places such as the Falkland Islands, but increased in others such as Peru since the end of commercial exploitation. Some exploitation still occurs in Uruguay and possibly Peru (Vaz-Ferreira 1979). Vaz-Ferreira (1982) summarizes the knowlege of the diet of this species. It is known to include fish, molluscs and crustaceans. Amongst the fish commonly eaten are Sebastodes oculatus, Merluccius gayii, Clupea bentinckii and Engraulis anchoita, as well as bottom fish, squids, and at least occasionally, penguins. There are known to be conflicts between this species and fishermen throughout most of its range, particularly with regard to damaged nets and catch (see area 41 and 87).

41 87

Neophoca cinerea (Peron, 1816) Australian sea lion
Scattered around the southern coast of Australia, this species breeds mostly on islands, with one colony on the mainland of South Australia. The most westerly colony occurs off

West Australia (about 28°S) and the the range continues around the south coast to Kangaroo Island off Adelaide (138°E) (King and Marlow 1979). Warneke (1982) estimates the total population at between 3 and 5 thousand. King and Marlow state that the diet is known to consist of local fish and squid, and both penguins and the fiddler ray (Trygonorhina sp.) have been noted as food items too (Warneke 1982). There is some conflict recorded between this species and fishermen (see area 57).

57

Phocarctos hookeri (Gray, 1844) Hooker's sea lion
Marlow and King (1979) state that this species is centred on the Auckland Islands 300 miles south of New Zealand, and also occurs in a few other sub-antarctic islands (the Snares and Campbell Island) as well as straggling as far as Macquarie Island. The population they estimate to be around 4 000 animals, which is possibly stable. Yaldwyn (1958) reports cephalopods, prawns, crayfish and crabs in the diet. Penguins have also been eaten occasionally (Marlow and King 1979). There is some interaction with fishermen in the region (see area 81).

81

Callorhinus ursinus (Linnaeus, 1758) Northern fur seal
Lander (1979) states that this species breeds in the high latitudes of the North Pacific on the Commander, Pribilof, and Kuril Islands, as well as Robben Island and San Miguel Island. In the winter they migrate south to the Japanese and American coasts as far as about 34°N. Lander estimated the total population as around 1,765,000 animals, nearly 3/4 of which breed in the Pribilof Islands and migrate to American waters in the winter. This species is exploited on a sustained management basis. During winter Wilke and Kenyon (1952) found that the diet of 148 animals examined consisted of around 99% herring whilst the remainder was pollack Theragra chalcogramma. Lander (1979) however states that food varies with season, age and area and consists of a number of items including squid, herring, hake, anchovy, sandlance, capelin, walleye pollack, atka mackerel and deep sea smelt. Perez and Bigg (1981) provide a detailed account of the feeding of this species, and suggest that Pacific hake Merluccius productus, northern anchovy Engraulis mordax, Pacific saury Cololabis saira, rockfish Sebastes, herring, salmon, and capelin, as well as a number of squid species are all important in the diet. There are reported interactions between this species and commercial fisheries (see areas 61 67 77).

61 67 77

Arctocephalus townsendi Merriam 1897 Guadaloupe fur seal
Restricted to a small part of the former range,this species breeds now only on part of the Isla Guadaloupe, Baja California, although individuals have been sighted in other areas around Baja California, particularly San Miguel Island (Peterson et al, 1968, cited by Hubbs 1979). Hubbs estimates the population size to be possibly more than 500, which is thought to be increasing. The species is fully protected, after nearly having been driven extinct by commercial sealing operations which destroyed the ca. 200 000 strong population. There is apparently no information on the feeding habits of this species, neither is there any record of interactions with fisheries. Such interactions, however cannot be ruled out especially for an increasing population.

77

Arctocephalus philippii (Peters, 1866) Juan Fernandez fur seal
This species is closely related to the preceding one (Repenning et al 1971), and is confined to the Juan Fernandez Archipelago off the coast of central Chile. The population is thought to number fewer than 1 000, possibly around 750, having been reduced from extremely abundant levels 300 years ago after the slaughtering of several million up to 1824. The population may be increasing at present (Aguayo 1979). Aguayo also states that the diet is thought to consist of several kinds of fish, cephalopods and a local spiny lobster (Jasus frontalis). There is some evidence of a number being killed by local fishermen (see area 87).

87

Arctocephalus galapagoensis (Heller, 1904) Galapagos fur seal
Confined to the Galapagos Islands, this species has also been nearly exterminated by commercial sealing since 1535. The population may have increased to as many as 5 000 at present, though other estimates have put the population at around 1 000. Clarke and Trillmich (1980) found that the diet is exclusively cephalopods, 94.6% of it ommastrephid squids. There are no records of interactions with fishermen. The species is anyway fully protected (Clark 1979).

77

Arctocephalus australis (Zimmerman, 1783) South American fur seal
Distributed around the coast of southern South America, from Rio de Janeiro in Brazil, southwards, including the Falklands/Malvinas Islands, to Tierra del Fuego, and then up the coast of Chile and Peru as far as Lima (Repenning et al 1971). The total population may exceed 320 000, 252 000 of which breed in Uruguay, and is thought to be increasing overall (Vaz-Ferreira 1979a). The population is managed in Uruguay, around 8 000 - 10 000 being taken per year (FAO 1983). Vaz-Ferreira goes on to state that the diet is known to include a number of fish species such as Engraulis anchoita, Trachurus lathami, Cynoscion striatus, Pneumatophorus japonicus, and Peprilus sp., as well as some cephalopods and crustaceans. Feeding takes place over a wide area of the continental shelf and beyond. Vaz-Ferreira (1982a) indicates that fur seals cause little or no disturbance to commercial fishing operations.

41 87

Arctocephalus pusillus (Schreber, 1776) Cape fur seal/Australian fur seal
There are two sub-species recognised, A. pusillus pusillus and A. pusillus doriferus (Repenning et al 1971). The former breeds along the coast and on offshore islands of Namibia and South Africa, wandering as far north as Angola and as far east as East London (28°E) (Shaughnessy 1982), and the latter ranges from around 152°E on the coast of New South Wales to about 138°E via southern Tasmania (Warnecke 1982). The populations are apparently isolated from one another. The total population of A. pusillus pusillus is estimated to be about 850 000, or 73% of the initial population size with an annual kill of around 78 000 pups (Shaughnessy 1979). The Australian population is estimated at around 20 000 and may now be stable (Warnecke 1982). Rand (1959) found that small schooling fish make up 60% of the volume of all food consumed, and gives a detailed analysis of the diet. The diet of the Cape fur seal consists largely of fish, and also squid, food species including Trachurus trachurus, Loligo spp., and pilchards (Shaughnessy 1979). The Australian fur seals' diet is less well known but may consist largely of squid (Notodarus, Sepioteuthis) as well as a variety of fish species such as barracouta (Thyrsites), and occasionally a number of other small fish species, e.g. red mullet, pilchards and parrot fish. Both of these subspecies are known to interact to some extent with fisheries, especially in South Africa (see areas 47 57 81).

47 57 81

Arctocephalus forsteri (Lesson, 1828) New Zealand fur seal
There are two geographically isolated populations of this species also. Breeding groups are distributed on islands around the southern coast of Australia, from the south western tip of Western Australia (117°E) to Kangaroo Island in South Australia. The second population is distributed around the coast and surrounding islands of South Island in New Zealand, and some of the subantarctic islands such as Macquarie, Chatham, Bounty, Stewart, Antipodes and Auckland Islands. In winter the range extends northwards along the coasts of North Island to 34°S (Crawley & Warneke, 1979). The Australian stock size is unknown, but it may not exceed a few thousand individuals, and is thought to be stable (Warneke, 1982). The New Zealand stock has been estimated at around 38 000 and is thought to be recovering from decimation last century (Crawley & Warneke, 1979). According to Warneke (1982) the diet consists mostly of barracouta (Thrysites), and also some octopus, squid and other small fish. Some conflict with fisheries may occur throughout the range (see areas 57, 81).

57 81

Arctocephalus gazella (Peters, 1875) Antarctic fur seal
The species is distributed on islands south of the Antarctic circle, including South Georgia, South Orkney, South Sandwich, Bouvetoya, South Shetland, Heard and McDonald Islands and possibly Kerguelen. The population is thought to be increasing rapidly following decimation by commercial sealing operations and was estimated to be around 363 000 in 1976, 350 000 of which are from South Georgia (Bonner 1979). Bonner (1982) suggests a total projected population stabilizing at around 1.5 - 2.5 million animals. The food is thought to be largely krill, but some fish, birds and squid are also known to be eaten (Bonner 1979). There are no well documented interactions with fisheries, but these could materialise if krill fishing is intensified in the region (see areas 48, 58, 88).

48 58

Arctocephalus tropicalis (Gray, 1872) Subantarctic fur seal
Known to breed on a number of subantarctic islands including Gough, New Amsterdam, St Paul, Prince Edward and Marion Islands, as well as Nightingale and Inaccessible Islands and occasionally on Tristan da Cunha, this species is also occasionally reported from the South African coast, Macquarie Island, the Crozet Archipelago and South Georgia (Bonner, 1979a). Shaughnessy (1982a) estimates the total population to exceed 23 400, whereas Bonner (1979a) gives a figure of more than 120 000. The population appears to be thriving after near extinction last century (Laws 1973). Rand (1956) found cephalopods to be the most important group in the diet of this species, which also included euphausiids and some nototheniid fish. According to Shaughnessy (1982a) other authors have described penguins in the diet too. There are no records of interaction with fisheries, and Shaughnessy (1982a) regards these as unlikely.

47 51 57

ODOBENIDAE

Odobenus rosmarus (Linnaeus 1758) Walrus
Two or possibly three sub-populations are recognised, in the Atlantic and Pacific oceans, and possibly the Laptev Sea. Distribution in the Atlantic is from the eastern Canadian Arctic and West Greenland, to Spitzbergen, Franz Josef Land, and the Barents and Kara Seas. In the Pacific area the distribution ranges from the Bering and Chukchi Seas to the Laptev Seas. The Pacific stocks are thought to number around 140 000, whilst the Atlantic stocks are thought to number less than 20 000. The stocks are thought to be recovering at present from over-exploitation, though a few thousand are probably still taken every year. The diet of the walrus consists of benthic invertebrates taken in shallow waters, especially molluscs, echinoderms, tunicates, crustaceans, echiuroids and priapulids, up to 45 kg of food being eaten per day. (Brenton 1979). Although there is no reported interaction with fisheries at present, development of mollusc fisheries in Arctic waters could affect walrus populations (Harwood 1981) (see areas 18 61 67).

18 21 27 61 67

PHOCIDAE

Phoca vitulina Linnaeus, 1758 Harbour seal
A widespread species found from Iceland, Norway, Britain and the East Atlantic as far south as the southern North Sea, and also in the Baltic, sparsely. In the West Atlantic the species occurs from Maine northwards up the coast of Canada and West Greenland to Hudson Bay and the Arctic Circle. In the Pacific the range extends from Baja California northwards to Bristol Bay and Herschel Island in Alaska. Also found in the Kuril Islands, northern Hokkaido, and the Aleutian Islands. There are thought to be around 400 000 worldwide more than half of which are found in Alaska, with around 30 - 50 000 on each side of the Atlantic also; the population may be stable. A few thousand are taken in kills every year. The diet is extremely catholic with a wide range of pelagic and demersal fish taken as well as cephalopods and crustacea. Gadids, clupeids, pleuronectids, salmonids and other fish of commercial importance are all included in the diet. (Bonner 1979c). There is some interaction with fisheries, as this species is both caught in nets

(e.g. Naito, 1976) and also eats commercial fish species (see areas 21 27 61 67 77).

18 21 27 31 61 67 77

Phoca largha (Pallas, 1811) Largha seal
Some authors regard this as a sub-species of P. vitulina, (e.g. Naito, 1976), it is distributed throughout the Sea of Okhotsk, Bering Sea, Chukchi Sea, Mackenzie Sea, Po Hai Sea and the north western part of the Yellow Sea, this species also occasionally turns up off the Japanese and Korean coasts. It is more closely associated with ice than the harbour seal, as it breeds on ice rather than land. The total population is unknown, but is thought to exceed 250 000 at least. There is a small amount of hunting at present. There is not much information on the diet of this species, but it is known to feed on fish, including salmon, as well as cephalopods and crustacea. (Bonner 1979b). There are records of some interaction with fisheries (see area 61).

18 61 67

Phoca hispida (Schreber, 1775) Ringed seal
There is a circumpolar distribution in the Arctic, often closely associated with the ice. Southern limits are marked by the Sea of Okhotsk, the northern Bering Sea as far as the pack ice, into the Hudson Bay, around Greenland and as far south as Labrador, the sea-ice of Eurasia, the upper reaches of the Baltic Sea, and Lakes Ladoga and Saimaa. (Stirling and Calvert 1979). Frost and Lowry (1981) describe the populations in Lakes Saimaa and Ladoga, in the Okhotsk Sea and in the Baltic as subspecies, P.h. saimensis, P.h. lagodensis, P.h. ochotensis and P.h. botnica respectively. This is said to be the most abundant of Arctic Ocean seals, with a total population of around 6-7 millions, which is thought to be fairly stable. Tens of thousands are harvested each year for their pelts (Stirling and Calvert 1979). Popov (1982) states that polar cod (Boreogadus saida) may account for around 90% of the diet in winter in northern European waters, other species being eaten then including navaga, smelt, sand eel and flounder. In summer crustaceans form the main part of the diet. In other areas, such as the White and Barents Seas, the main food items may include commercial species such as herring and navaga. Similar species are consumed in the Pacific. Salmon are also eaten, especially around the Kola Peninsula. There are records of incidental catches too (see areas 27 and 61).

18 21 27 61 67

Phoca sibirica (Gmelin, 1788) Baikal seal
Confined to Lakes Baikal and Oron, there are an estimated 50 - 60 000 seals, mostly in Lake Baikal; an annual kill takes 2 - 3 000 (Popov 1982). Popov (1982) describes the diet of this species as being Comephoris baicalensis, 72% of the diet by weight, with the rest (25%) being made up mostly from sculpin (Cottus sp.). Commercial species are said to make up less than 1% of the diet. There are no reported interactions with fisheries (Popov 1982).

04

Phoca caspica (Gmelin, 1788) Caspian seal
Confined to the Caspian Sea, with an estimated total population of around 500-600 000. There is an annual kill of around 60 - 65 000 pups. The diet is varied, but sprat Clupeonella delicatula is said to be the main food, whilst other species which are eaten are known to include small fishes such as bullheads, sand smelts, herring, roach, carp, pike-perch, shrimp, amphipods and crayfish. There are thought to be no interactions with fisheries. (Popov 1982).

04

Phoca groenlandica (Erxleben 1777) Harp seal
Three stocks are recognised in this species, one centred on the pack ice of the White Sea, another around Jan Meyen Island, and a third around Newfoundland and the Labrador coast in Canada. During summer, feeding animals range northwards following receding pack ice, up as far as Thule in West Greenland, and in the northern Barents Sea and Kara Sea north to Svalbard. All three stocks are hunted, about 40 000 animals, mostly pups, being

taken from the White Sea population every year, about 10-15 000 pups from the Jan Meyen stock, and about 150 000 pups from the Newfoundland stock, which is much the largest of the 3. (Lavigne 1979). There has been some considerable debate over the size of pup production in each area, and hence the inferred size of the populations, but it would seem that the total population is somewhere between 1.2 and about 2.5 million animals (ICES 1982). Beddington and Williams (1980) have summarised information on Harp seal feeding in the Northwest Atlantic. The diet is varied and includes crustaceans when young, especially Thysanoessa spp., and Pandalus borealis. Fish consumed include Capelin Mallotus villosus to a large extent, but also herring, cod, flatfish and redfish. Lavigne (1979) points out that arctic cod (Boreogadus saida) are important items in higher latitudes, whilst Popov (1982) also states that Arctogadus glacialis and Mallotus villosus are important foods in the White and Barents Seas. Cephalopods are also eaten, but it is unclear how important they are in the diet overall. There have been a number of reported interactions between this species and fisheries (see areas 21, 27).

18 21 27

Phoca fasciata Zimmerman, 1783 Ribbon seal
Found in the Sea of Okhotsk and Bering Sea, and to a lesser extent in the Chukchi Sea, this species ranges as far as the limit of the drifting pack ice. There is some commercial harvest around 9 000 being taken in the Bering Sea, and an unknown number in the Sea of Okhotsk. The population has been estimated at between 200 - 250 000 animals, and could be declining. The diet is reported to include crustaceans (shrimps, crabs and mysids), followed by fish (including Boreogadus saida, Theragra chalcogramma, and Gadus macrocephalus in the sea of Okhotsk) and cephalopods in third place (Burns 1981). There does not appear to be any appreciable interaction between this species and commercial fisheries.

18 61 67

Erignathus barbatus (Erxleben, 1777) Bearded seal
This species has a circumpolar Arctic distribution, preferring moving pack ice over shallow waters, and is known to wander as far south as Scotland, the Gulf of St Lawrence, Hokkaido and Norway. There are no estimates of world population, but this probably exceeds 500 000. The annual kill of this species exceeds 10 000, and it may be declining in some areas (Stirling and Archibald 1979). Popov (1982) states that this species is known to eat more than 70 species, including fish (especially polar cod, but also herring, navaga, flounder and sand eel), molluscs, crabs, shrimps and worms. There are some minor interactions with fisheries reported (see area 61).

18 21 27 61 67

Cystophora cristata (Erxleben, 1777) Hooded seal
The hooded seal breeds off Jan Meyen Island, and off Newfoundland, in the Davis Strait, and in very small numbers in the Gulf of St Lawrence and the southeast Bering Sea. It may be found along both coasts of Greenland in summer. The Jan Meyen population is apparently the larger of the two, with a pup kill of around 30 000 per year, whilst about half this number are taken from the Newfoundland population (Sergeant 1979). The data is not sufficient for any population assessment to be made on the basis of the pup kills and associated tagging programmes (Goodman 1982), but the total population presumably numbers in hundreds of thousands for such a pup kill to be operable over the number of years it has done so. Indeed Popov (1982) maintains that the total population numbers 500 - 600 000 animals, 80 - 90% being in the Jan Meyen stock. There is also argument over whether the level of the kill is affecting the population stability at present (ICES 1983). The diet consists of Gonatus fabricii, Sebastes marinus (redfish), Rheinhardtius hippoglossoides (Greenland halibut), Mallotus villosus (capelin), and Boreogadus saida (polar cod) (Sergeant 1979), as well as herring, salmon, tusk, starfish, catfish, sandeels, rays, amphipods and whelks (Oritsland, pers. comm.). There are some minor interactions with fisheries (incidental catches in salmon nets) reported, but Sergeant implies that the low stock size, catholic diet and migratory habits make anything more dramatic very unlikely (see areas 21 and 27).

18 21 27

Halichoerus grypus (Fabricius, 1791) Grey seal
Three stocks have been identified, a West Atlantic stock distributed around the Gulf of St Lawrence, Newfoundland, and the Maritime States, a Baltic stock confined to the Baltic Sea and an East Atlantic stock which breeds mainly around Britain, especially Scotland, but which also extends to Iceland, Norway, and around to the north coast of Russia, as well as to Ireland and the Faroes. This last stock is much the largest of the three (Bonner 1979d). Both the East and West Atlantic stocks are thought to be increasing at present after severe reduction last century (Bonner 1979d), whilst the Baltic stock is decreasing and at present may number no more than 3 - 5 000 (Stenman 1978). The British population is said to comprise 60% of the entire population (Bonner 1981a), and in 1983 the Sea Mammal Research Unit estimated the number of breeding grey seals in the British Isles to number around 80 000, suggesting a world population of about 130 000 animals.

The diet is known to include salmon and cod, but recent studies have shown these two items are probably trivial in the diet of seals in British waters (see area 27). The most important food species were found to be small so-called 'industrial' fish, especially the sand eel Ammodytes, but other fish including whiting and ling were also important (NERC 1984). Bonner (1981a) also lists skates, cephalopods and crustacea as important food items in some studies. The grey seal has been implicated in a number of controversies with fisheries (see areas 21 and 27).

21 27

Monachus monachus (Hermann, 1779) Mediterranean monk seal
Formerly abundant in the Mediterranean, Black Sea and along the coast of North West Africa, this species has now been reduced to a handful of isolated groups within its former range, notably some of the islands off north West Africa, and also some of the Greek Islands (Boulva 1979). The total population size is unknown but has been estimated from visual surveys to be around 5 - 800, and declining steadily (Ronald and Healey 1982). The diet is said to include eel, carp, whiting, sardine, bonito, octopus, lobster, Dentex, Labra, whitefish, Mullus surmuletus, Boops boops, Mugil cephalus, and other fish, including flatfish, species. (Boulva 1979). There has been some record of interaction between fishermen and this species in the Mediterranean (see area 37).

27 34 37
(Monachus tropicalis (Gray, 1850) Caribbean monk seal
Considered to be extinct, this species was once found in the Caribbean and Gulf region from the Bahamas to Florida, and to the Yucatan and Nicaragua. None have been positively identified since 1952 (Boulva 1979).)

31

Monachus schauinslandi (Matschie, 1905) Hawaiian monk seal
The Hawaiian monk seal is found on a number of islands to the west and northwest of Hawaii, with numbers probably declining due to disturbances by man (Kenyon 1972). The latest population estimate based on visual surveys put the total population at around 700 - 1 000 animals. Little is known of the diet, but it is thought to include cephalopods and reef bottom fish. (Brenton 1979a). There are some indications of gear conflicts (see area 77).

77

Mirounga leonina (Linnaeus, 1758) Southern elephant seal
Laws (1979) states that there are three main stocks, centred on South Georgia, but including parts of mainland South America, the Falklands and the Scotia arc, numbering around 300 000; on Kerguelen and Heard Islands, numbering around 200 000 and a third stock on Macquarie Island and the New Zealand subantarctic islands, numbering about 100 000. The populations are thought to be more or less stable. The diet of elephant seals consists of both fish and squid. Pascal (1984 in press) has suggested that fisheries may have affected the population dynamics of the Kerguelen stock, but this has been disputed by McCann (1983) (see area 58).

41 48 57 58 81 88

Mirounga angustirostris (Gill, 1866) Northern elephant seal
Ranging as far north as British Columbia, and at least 240 km from the shore, the breeding sites of this species are confined to offshore islands from Baja California to central California. The population is at present estimated to number 45 000, and is still increasing fast from a low point of less than 100 individuals in the late nineteenth century (Le Boeuf 1979). The diet is known to consist of a number of fish including bottom fish and elasmobranchs, and also some squid (Morejohn and Baltz 1970). Some gear interactions have been recorded (see area 77).

67 77

Lobodon carcinophagus (Hombron & Jacquinot, 1842) Crabeater seal
Confined to the Antarctic pack ice, this is thought to be the most numerous of all pinniped species, with a total population of around 15 million animals. Since the reduction of the baleen whale stocks in the Antarctic, this species may have increased in abundance. The food is almost exclusively krill, mostly Euphausia superba (Laws 1979a). There are no recorded interactions with fisheries, apart from the possible reaction to commercial whaling already mentioned. It is worth noticing, however, that any predation on commercial species (krill) might be significant merely as a consequence of the size of the population.

48 58 88

Ommatophoca rossi (Gray, 1884) Ross seal
Generally restricted to the consolidated ice pack of the Antarctic, one individual has been sighted north of 55°S, at Heard Island. The world population may number around 220 000, which is possibly stable. The food is thought to consist of cephalopods (Laws and Hofman 1979). There are no interactions between this species and fisheries at present.

48 58 88

Hydrurga leptonyx (de Blainville, 1820) Leopard seal
The distribution of this species is similar to that of the crabeater seal, i.e. throughout the unconsolidated pack ice of the Antarctic. Stragglers, however, have been sighted in most of the southern continents; it is also reasonably abundant on the subantarctic islands. The world population may be as much as 500 000. The diet is known to consist of penguins and seals, as well as krill, but the relative importance of these items is not known. It is possible that the crabeater seal is the main food supply of adult animals (Hofman 1979). There are no recorded interactions between this species and any fishery at present.

47 48 57 58 81 88

Leptonychotes weddelli (Lesson, 1826) Weddell seal
This species inhabits the fast ice region of the Antarctic, but is also known to breed as far north as South Georgia. There have also been sightings in Uruguay, the Falklands, the Juan Fernandez Islands, New Zealand, South Australia, Macquarie Island and Heard and Kerguelen Islands. The world population is estimated as at least 750 000, which is an underestimate, as inshore regions have not been surveyed. The food is thought to consist largely of fish, including the species Dissostichus mawsoni, Trematomus sp. and Pleuragramma antarcticum (De Master 1979). As yet the lack of fisheries in the areas inhabited by this species has meant that there are have been no recorded interactions.

41 48 57 58 81 87 88

2.3 SIRENIA

TRICHECHIDAE

Trichechus senegalensis (Link, 1795) West African manatee
Husar (1978) describes the distribution of this animal as from Senegal to Angola, along

the West African coast, in river estuaries and in rivers for up to several hundred miles in places. There are no population estimates nor estimates of abundance, but Husar describes the population as severely reduced, although in areas it may still be present in considerable numbers. Although it is protected in most areas now, there is still continued illegal hunting in many areas. The animals are said to prefer shallow weedy estuaries, as they feed on vascular aquatic plants (Husar 1978). Shark netting is said to have a considerable effect on this species (see areas 34 47).

34 47

Trichechus manatus (Linnaeus, 1758) Caribbean manatee
Bertram and Bertram (1973) describe the distribution of this animal as from North Carolina, through Florida to Texas in the Gulf of Mexico, along the Caribbean and Atlantic coasts of Central America, as far as the Guianas and the Atlantic coast of northern Brazil, and to the Bahamas and Greater Antilles. There are no estimates for the total population, but this is thought to be declining throughout the range (FAO 1978). The population in Florida is thought to number about 1 000 (Campbell and Powell 1976). The food is aquatic vascular plants, in freshwater and salt water (FAO 1978). The decline in the population may in part be due to local fisheries (see area 31).

31

Trichechus inunguis (Natterer, 1883) Amazonian manatee
The Amazonian manatee is confined to the Amazon river basin, and possibly in the Orinoco (FAO 1978). A minimum estimate of 10 000 animals has been suggested (IUCN 1976) sparsely distributed throughout the range. The population is said to be severely reduced. The diet of this animal is the same as other sirenia, aquatic vascular plants. (FAO 1978). Fishing operations are known to affect this population (see areas 41).

41 (03)

DUGONGIDAE

Dugong dugon (Muller, 1776) Dugong
Bertram and Bertram (1970, 1973) describe the distribution of this species as from Madagascar and Mozambique in shallow coastal waters up the African coast to the northernmost end of the Red Sea, eastwards through India to southeast Asia, north to the Ryukyu Islands, and south and east to Yap, Guam, Papua New Guinea and New Caledonia, and south to the north, east and west coasts of Australia. There are no estimates of total population, but Bertram and Bertram (1970) describe it as rare throughout the range, except in northern Australia and Papua New Guinea. The diet is the same as for manatees. The decline of this species has been precipitated in part by fishermen, and throughout the range accidental nettings are an important source of mortality (FAO 1978) (see areas 51, 57, 77).

51 57 67

3. AREA ACCOUNTS

3.1 AREA 18: ARCTIC SEA

MARINE MAMMALS FOUND IN AREA 18

Balaena mysticetus Bowhead whale
Braham (1982) estimates the Beaufort Chukchi and Bering Sea stocks to number around 4000, from an estimated initial population of 18 000. Braham et al (1979) have also estimated that the Beaufort Sea part of this stock numbers around 2 200. In 1981 28 bowhead whales were struck by US Inuit whalers, of these 17 were landed. An unknown proportion of animals which were struck but not landed probably die (IWC 1983 p 142).

Eshrichtius robustus Grey whale
Hershkovitz (1966) states that this species occurs as far north as 72°N. The food is thought to include bottom dwelling invertebrates, but not fish.

Balaenoptera physalus Fin whale
Tomilin (1967) suggests that the diet of this species is mostly crustaceans in the more northerly parts of its range.

Balaenoptera musculus Blue whale
The diet is composed of large crustaceans (Tomilin 1967).

Balaenoptera acutorostrata Minke whale
Occurring up into the ice fields, the diet of this species in high latitudes remains unclear, but could presumably include arctic cod.

Megaptera novaeangliae Humpback whale

Physeter macrocephalus Sperm whale

Monodon monoceros Narwhal

Delphinapterus leucas White whale
Fraker (1980) has estimated the Mackenzie stock, in the Beaufort Sea, of this species as 4 or 7 000 individuals. Around 300 animals are taken by Inuit and Inupiat hunters in this area each year (Fraker 1980). Other data are given in the species account.

Orcinus orca Killer whale

Phocoena phocoena Harbour porpoise

Odobenus rosmarus Walrus
Harwood (1981), citing Fay et al, has pointed out that if the walrus population is near its carrying capacity, and is limited by its food supply, then the development of a clam fishery in northern waters could affect the dynamics of the walrus population. About 6 000 animals are also taken every year for human consumption and dog food.

Phoca vitulina Harbour seal

Phoca largha Largha seal

Phoca hispida Ringed seal

Phoca groenlandica Harp seal

Phoca fasciata Ribbon seal

Erignathus barbatus Bearded seal

Cystophora cristata Hooded seal

Very little is known of the feeding habits or population sizes of marine mammals in the arctic regions of area 18. Presumably pelagic crustaceans are important in the diets of most species.

THE FISHERIES OF AREA 18

There do not appear to be any commercial fishing operations in this area. The FAO Yearbook of Fishery Statistics (1983) indicates that the total catch of 3 groups of fish, namely flounders, halibuts, soles etc., cods, hakes, haddocks etc. and 'miscellaneous fish' was zero for the year 1981.

A number of species of marine mammal are hunted in this area for subsistence purposes.

There is little data on the size of these catches, except for the bowhead and white whales which are mentioned above.

There are no records of interactions between any local or artisanal fisheries and marine mammals.

According to Marquette et al (1982) about 95.8% of all zooplankton and nekton in the Beaufort Sea area are consumed by arctic cod (Eleginus navaga). Presumably therefore this species makes up a considerable part of the predatory biomass of the arctic regions. So far it is only exploited in areas 27 and 61 by the USSR.

3.2 AREA 21: NORTHWEST ATLANTIC

MARINE MAMMALS FOUND IN AREA 21

Eubalaena glacialis Right whale
Reeves and Mead (1978) have recorded a number of this species becoming entangled in fishing gear. They report one individual tangled in the lines of a lobster pot off New Jersey in 1976, though this was later released. Another was reported entangled in netting at Cape Cod in 1976, and two more historic accounts of whale entanglement are mentioned. They conclude that whilst "there is no evidence to indicate that such entanglement happens often, or that it invariably leads to death or debilitation ... it should not be overlooked as a potential hazard to individual whales and therefore as an obstacle to the recovery of this small stock." The population size is unknown, but the report of the sub-committee on Protected Species and Aboriginal Whaling (IWC 1983) indicates that 59 individuals have been photo-identified. A population in the hundreds might be expected. The same report indicated that faecal analysis showed a diet of copepods.

Balaena mysticetus Bowhead whale
Mitchell and Reeves (1981) suggest two Bowhead Stocks, with approximately 700 in the Hudson Bay area, and 600 in the Davis Strait/Baffin Bay area. These represent 15% and 5% respectively of the estimated initial population sizes of the 2 stocks, before exploitation. There are few fisheries in this area at present, and few opportunities for interaction. The diet does not include any fish species (Tomilin 1967).

Balaenoptera physalus Fin whale
Perkins and Beamish (1979) record the entrapment of one individual of this species in a salmon net off Labrador. The Canadian Progress Reports to the IWC list 7 other such cases of entrapment in gill nets off Newfoundland in 1979, 3 in 1980, 1 in a herring net and 2 in gill nets, and another 1 in 1981 in a herring net. About half of these appear to have been found dead. As has been noted, fin whales are also known to eat commercial fish such as herring, capelin and arctic cod (Jonsgaard 1966, Tomilin 1967), although so far in area 21 this does not appear to be a problem. The population size may be in the thousands for this area.

Balaenoptera musculus Blue whale
The number of blue whales left in the north west Atlantic is unknown but considered very small, and may not exceed a few hundred. No fish are consumed by this species.

Balaenoptera acutorostrata Minke whale
This species seems to become entangled in fishing gear fairly frequently, and records of such cases may be found in the Progress Reports of Canada in the annual Report of the IWC. In 1981 only 1, dead, individual was recorded from a 'commercial net'. In 1980 12 were recorded, 10 of which were dead. These were trapped in salmon nets, gill nets, and traps, including salmon traps. 9 entrapments are recorded for 1979. Perkins and Beamish (1979) estimate that an average of 3 minkes a year are caught in fishing gear in Newfoundland, with a minimum mortality rate of 0.77 in such cases. They state that most records are from cod traps, with a few from gill nets. The minke whale has already been mentioned as another fish eating whale known to feed on some commercial species, although, as with the fin whale, this does not appear to present a problem at present. Again, the population size in this area is unknown. A figure in the low tens of thousands

however may not be too unreasonable.

Balaenoptera borealis Sei whale
The stocks of sei whales in this area are still protected by IWC regulations. Gambell (1977) gives an estimate for the north west Atlantic population of 2 078 based on sightings estimates. Mitchell and Chapman (1977) have identified two separate stocks, with centres of abundance in the Labrador Sea and on the Nova Scotia Shelf. Tag-recapture experiments have yielded estimates for the size of the latter population at between 1 393 and 2 248 whales. The Labrador stock is reported to have a minimum of 965 whales from census data. No interactions are recorded.

Balaenoptera edeni Bryde's whale
Mead (1977) reports the most northerly record of this species on the U.S. Atlantic coast as 37°59'N, which is just inside area 21. The population in this area is likely to be very small, and there are no reports of conflicts with fisheries in area 21.

Megaptera novaeangliae Humpback whale
This species is perhaps the most involved in gear entanglements of al baleen whales in this area, and numerous accounts are given in the Canadian Progress Reports to the IWC, with 33 records in 1981. The 1982 Progress Report indicates a total of 43 humpbacks killed in nets from 1969-1980, with a further 88 having been released alive from nets. Humpbacks are particularly prone to this type of interaction as they feed on the capelin stocks in the waters around Newfoundland (Perkins and Beamish 1979), and the effect of such levels of mortality on the recovery of the humpback population cannot be insignificant. Whitehead (1982) has also put forward one view that the fact that the capelin stocks in that region have been severely overfished may also hinder the recovery of this stock of humpback whales. Perkins and Beamish also noted that most entanglements occurred in cod traps, as well as salmon nets, and that such entanglements were extremely expensive for the fishermen to whom the nets belonged. They state that cod traps in 1978 cost US $7-8 000. The population size of this species in the north west Atlantic has been estimated by sightings and acoustic records to number between 1000 and 1 500 in 1978 (Balcomb and Nicholls 1978) and between 2 300 and 4 100 by Whitehead (1982).

Mesoplodon bidens Sowerby's beaked whale
There are no reported interactions with fisheries, and the population size of all members of this genus remain unknown. Very few individuals of any species have been recorded.

Mesoplodon densirostris Blainville's beaked whale
-

Mesoplodon europaeus Gervais' beaked whale
-

Mesoplodon mirus True's beaked whale
-

Ziphius cavirostris Cuvier's beaked whale
Hershkovitz (1966) states that this species occurs as far north as Rhode Island on the American side of the Atlantic. There are no population estimates, and no apparent interactions with fisheries. This species feeds on squid.

Hyperoodon ampullatus Northern bottlenose whale
Benjaminsen (1972) provides an account of feeding and distribution. This species was until recently hunted by the Norwegians and Mitchell (1977) has suggested that the population is currently depleted. Preferring deeper waters the bottlenose whale spends the summer in high latitudes, and feeds on squid. Interactions with fisheries seem unlikely at present.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps show some of the densest regions of exploitation of sperm whales in the western central Atlantic south of 40°S; the 'western' and 'southern' grounds straddle the boundary between area 31 and area 21. The population size in area 21 is unknown, but may be in the low tens of thousands in summer at least. The report of the sub-committee on sperm whales (IWC 1982) gives an estimate of 58 000 for the stock exploited by Icelandic whalers. The development of squid fisheries in area 21 may affect some interaction, operational or biological, with this species, but none are known at

present.

Kogia breviceps Pygmy sperm whale
Sergeant and Fisher (1957) record the presence of this species in Canadian waters as one individual. Although strandings are not uncommon on the east coast of the U.S., it is apparently not common on a world scale. No population estimates are available. There are no recorded interactions with fisheries.

Monodon monoceros Narwhal
This species is still hunted in northern Canada, especially around Baffin Island; 406 individuals were taken in 1981 (IWC 1983 p 160). The report of the small cetacean sub-committee (IWC 1981) refers to one estimate of the narwhal population in the Lancaster Sound area being around 20 000. The narwhal also eats a number of commercial species, including Greenland halibut, and some crustacea (Finley and Gibb 1982), although as yet this has led to no apparent conflict.

Delphinapterus leucas White whale
Between 616 and 703 white whales were taken in Canada in 1981 (IWC 1983 p160). The report of the small cetacean sub-committee (IWC 1982) give an estimates for white whale stocks in the east Canadian arctic of around 9 000 whales. This species also eats some commercial species (see Gurevich 1980), but again no conflict with fishing interests is apparent.

Pseudorca crassidens False killer whale
Although no conflicts have been recorded between this species and fishermen in area 21, conflicts may be noted in other parts of the world notably Japan (see area 61) where this species eats both commercial fish and squid, and damages fish on lines. Accordingly such conflicts cannot be ruled out in the future in other parts of the world.

Orcinus orca Killer whale
This species is also noted for conflicts in other parts of the world, due in part to its fish eating habits (see IWC 1982 pp628 - 629), but as yet no such conflicts have been recorded in area 21. The diet in this area may include harp seals and minke whales (Sergeant and Fisher 1957); there are no population estimates for this species in area 21.

Globicephala melaena Long-finned pilot whale
No longer subject to any commercial hunting in area 21, this species is widespread especially around Newfoundland where it feeds on commercial squid, and to some extent fish, (Sergeant 1962). It has rarely been reported entangled in fishing gear such as traps and gill nets in Newfoundland (see Prog. Rep. Canada, IWC 1982). Interaction seems therefore to be minimal at present, but the presence of squid fisheries in the area could represent another potential interaction as indicated by Mercer's (1975) analysis which linked a decline in the catches of pilot whales with an increase in those of squid.

Lagenorhynchus albirostris White-beaked dolphin
This species is known to feed on herring, cod and other commercial species (Tomilin 1957, Sergeant and Fisher 1957). There are no estimates of population size, but the population, however, is thought to be centred more in area 27. The extent to which commercial fish species are present in the diet suggests that some degree of interaction is likely. Leatherwood and Reeves (1983) state that it is common in spring off Cape Cod, and abundant, at least seasonally, further north.

Lagenorhynchus acutus White-sided dolphin
Katona et al (1978) have found one individual of this species which was presumed to have been killed in a gill net in the Gulf of Maine, and which also had herring, squid and hake remains in its stomach. Gaskin (1983) also states that this species is taken incidentally in the mackerel (set) nets of Cape Cod Bay. Leatherwood and Reeves (1983) suggests that this is another fairly common species, adding that it used to be caught incidentally in the Newfoundland drive fishery for pilot whales. There is some possibility of this species competing for food with commercial herring and other fisheries, but as yet this has not been reported.

Tursiops truncatus Bottlenose dolphin
Although this species is frequently reported in fishing nets from around the world there do not appear to be any records of such entanglements in area 21; Sergeant and Fisher (1957) describe it as rare in Canadian waters, but it is more common further south in area 21, where it has supported some commercial fishing (Mitchell 1975). The diet is very varied (Tomilin 1967) and is likely to include some commercial species.

Grampus griseus Risso's dolphin
No population estimates are available for this species. No interactions are known at present, the diet is thought to be confined to squid.

Stenella coeruleoalba Striped dolphin
Hershkovitz (1966) states that it is found from southern Greenland to Argentina. There are no population estimates or interactions with fisheries recorded for this area.

Delphinus delphis Common dolphin
Known to eat small fish including some commercial species, there do not seem to be any by-catches in this area, and no other records of interactions with fisheries. Presumably, however, there is some degree of 'biological' interaction, which at present remains obscure.

Phocoena phocoena Harbour porpoise
There is a directed take of this species in West Greenland amounting to a few hundred a year. Incidental catches of this species are also apparently common along much of the Canadian and US coasts in area 21. Gaskin (1983) summarizes information on the catches of this species, and states that its feeding habits and neritic habitat virtually ensure its vulnerability to a number of net types. Gill nets cause the majority of deaths which may amount to a few thousand a year, although other gear such as cod traps, set nets and weirs are also responsible for some deaths. Food fishes are known to include a number of commercial species including herring, mackerel and small gadoids (Gaskin 1983).

Odobenus rosmarus Walrus
The population in the Atlantic is recovering from severe depletion and at the moment there appears to be no interaction with fisheries, although as Harwood (1981) has pointed out concerning the Pacific population, any development of a shellfish fishery in more northerly waters could alter this situation. Brenton (1979) estimates the population in area 21 to be in the region of 10 000.

Phoca vitulina Harbour seal
A varied diet including commercial species suggests that there is bound to be some interaction between this species and fishermen locally. Bonner (1979c) states that some animals are hunted for fur in northern regions, but there are apparently no data on incidental catches. The population may number around 20 - 30 000 (Bonner 1979c).

Phoca hispida Ringed seal
The northerly distribution of this species may prevent conflicts with fisheries; however flounder, arctic cod and crustaceans are all known to be eaten (Popov 1982). The population in area 21 is unknown, but this is possibly the most numerous seal in Arctic regions, with a total population of 6-7 million (Stirling and Calvert 1979).

Phoca groenlandica Harp seal
This species has been hunted extensively for a considerable length of time, and still supports an annual kill of thousands of pups and adults. Interactions with fisheries have been limited to capelin; the depletion of the capelin stocks of the Newfoundland area have led to the suggestion that this may affect the population dynamics of the capelin eating harp seal (IUCN 1981), but these effects are at present unclear. The NCC (1982) states that "on the available evidence, it is uncertain whether this stock - for which the range of current estimates is 1-2 million animals - is increasing or decreasing." They add that changes in the food supply may affect the chances of recovery of this stock.

Erignathus barbatus Bearded seal
There does not appear to be any conflict between this northerly species and fisheries

although some commercial species including herring and flounder are known to be eaten (Popov 1982). There are no population estimates from this area (Stirling and Archibald 1979).

Cystophora cristata Hooded seal
Sergeant (1976) states that there is some mortality associated with discarded fragments of netting, and Sergeant (1979) also states that there is some mortality associated with the salmon drift nets of the West Greenland salmon fishery, although he maintains that this is unlikely to have any significant effect on the population. The diet includes a number of commercial species although it is very catholic, which may reduce the likelihood of conflict. The population size is unknown, but may be in the hundreds of thousands (Reeves and Ling 1981). The NCC (1982) adds that although there is no reliable method to estimate the population size, the available evidence suggests that the population is still declining even after a reduction in the size of the commercial harvest.

Halichoerus grypus Grey seal
Food is known to include commercial species including cod, hake, herring, and occasionaly salmon (Mansfield 1963). Although there appears to be no data on incidental kills in area 21, Bonner (1981a) refers to considerable damage to Canadian fisheries which is attributed to Grey seals. Nets set for mackerel may be emptied of their catch, and Grey seals may be responsible for stealing cod from line fisheries, and for stealing bait from lobster traps. Grey seals have also been culled in Canada because they are hosts to the nematode Porrocaecum decipiens which infests fish and considerably reduces their value. The population in area 21 may be around 22 000 (Bonner 1979d).

Of the 33 species listed above, at least 12 are known to eat commercial fish species, and 4 or 5 others probably do also. Of the remainder possibly 4 of the baleen whales feed only or mostly on swarming crustacea, and 10 species are thought to feed mostly on squid. The walrus and the striped dolphin may feed on benthic and small mesopelagic organisms respectively, which at present probably present little overlap with fisheries.

At least 7 species have been reported in gear interactions, mostly in fixed and gill nets around Newfoundland. Although the reportage of these gear interactions is relatively good, it would seem probable, given the number of marine mammals which are known to feed on commercial fish stocks in the area, that many more such go unreported. It is also worth noting that even in this area which is one of the better documented fisheries areas, there is very little information relating to presumed or actual 'biological' conflict between marine mammals and fisheries. It would seem likely that this is either already, or else is likely to become, an important factor in the population dynamics of a number of species and the future of a number of fisheries, even though it remains poorly documented. This may be particularly important in the case of the harp seal population, which is probably the most important mammalian predator of fish in this area after man.

THE FISH STOCKS OF AREA 21

DEMERSAL FISH RESOURCES

The demersal fish resources of this region have been exploited for centuries, by European as well as North American boats; the cod fishery in particular has been very important in the history of the fisheries of this region (Innis, 1954). As with other temperate water areas the catch is made up to a large extent by comparitively few species, of which the members of the family Gadidae are by far the most important. Cod alone is estimated to have a potential of around 1.5 million tonnes. The FAO Yearbook of Fisheries Statistics recorded the annual catch of all demersal species for 1981 as 1 225 998 tonnes. Nearly all the stocks are heavily fished, and some have been depleted by over-exploitation (see reports from the Northwest Atlantic Fisheries Organisation, NAFO, and its predecessor, the International Commission for the Northwest Atlantic Fisheries, ICNAF).

GADIDAE

Gadus morhua Atlantic Cod.
The total recorded catch of this species was 588,318 tonnes in 1981. Garrod (1977) lists 10 separate important cod stocks in the northwest Atlantic region. Although cod extends as far north as around 70°N on the coast of West Greenland, the main area of cod exploitation and abundance lies further to the south off Labrador, Newfoundland, and as far south as Nova Scotia, within which area it is the most abundant commercial species.

Cod are known to make annual migratory movements in these regions following the spawning migrations of the capelin stocks, and may be found near the bottom from near shore surf areas to depths exceeding 200m (NOAA 1983). Migrations occur offshore in spring to spawning grounds and fish then move into shallower waters in the summer. Cod is taken both by modern trawlers, now, with the departure of most of the European long range fleets, predominantly Canadian and U.S., and also by artisanal fisheries in cod traps and other types of gear, particularly in the inshore waters of Newfoundland. Of the US catch in 1981 between 11 and 33% of the catch was taken by gill netting (NOAA 1983).

Melanogrammus aeglefinus Haddock.
This species is one of several which are of major commercial importance in the Nova Scotia and New England areas, and which replace the dominance of cod in those more southerly regions. Individuals of this species may weigh up to about 5Kg and are most common in depths of 43-135m, ranging from West Greenland to Cape Hatteras (NOAA 1983). Catches for the whole area exceeded 80 000 tonnes in 1981, which represents a recovery from annual catches of less than 30 000 tonnes in the early 1970's, after boom year catches of more than 200 000 tonnes in the late sixties (FAO 1981, Gulland 1983). One of the most important stocks is fished on Georges Bank off New England, which stock alone accounted for 25 000 tonnes of the 1981 catch (NOAA 1983). Almost all of the catch is accounted for by Canada and the US, using gill nets and otter trawls (FAO 1983 NOAA 1983).

Merluccius bilinearis Silver hake.
This species extends from the Newfoundland Banks to South Carolina, with major concentrations again off the New England coast. Spawning occurs in shallow waters from March to November, whilst extensive migrations of adults lead to overwintering in the deeper waters of the Gulf of Maine, and the outer slopes of the continental shelf. Adults may grow up to about 65 cm (NOAA 1983). The catch of this species has declined from over 170 000 tonnes in 1976 to 61 000 tonnes in 1981 (FAO 1983); this is thought to be due to a severe decline in stock biomass which started in the 1960's and which has been recovering only slowly and in places since the early 1970's (NOAA 1983). Of the 61 000 tonnes taken in 1981, 40 000 tonnes were taken by the USSR, and most of the rest by the USA (17 000 tonnes). The fishery is mostly by trawl (Gulland 1971). FAO (1981) estimates the total potential of this species at around 250 - 500 000 tonnes.

Urophycis tenuis White hake.
26 000 tonnes were landed in 1981, of which 19 500 tonnes was taken by Canada, catches having been stable since 1977 at least (FAO 1983).

Pollachius virens Saithe.
58 000 tonnes were taken in 1981 which shows an increase over the preceding 5 year period, two thirds of this was taken by Canada and one third by the U.S. (FAO 1983). The increase in catches is the result of increased directed effort in the past five years where previously saithe was taken mostly as a by-catch with other groundfish species. Saithe are most abundant on the southwestern Scotian Shelf and in the Gulf of Maine. As juveniles they are found in inshore and shallow waters, moving offshore as they grow older. Saithe may grow to about 16kg in weight (NOAA 1983).

SCORPAENIDAE

Sebastes spp. Redfish.
Between 100 and 200 000 tonnes of two or three species of Atlantic redfish have been taken in each of the past 6 years (FAO 1983). The U.S. fishery at least has experienced a

decline in CPUE for Sebastes fasciatus and a decline in the index of its abundance (stratified mean catch per tow) in the past 3 or 4 years (NOAA 1983). Gulland (1983) too provides data (table 5-9) indicating a decline in the catches of redfish in ICNAF area 3. Redfish are relatively deepwater species, slow growing, attaining lengths of around 50 cm. They are fished throughout the region, from West and South Greenland (esp. S. marinus) south to Newfoundland (S. mentella) and to the Gulf of Maine (esp. S. fasciatus) (FAO 1981, NOAA 1983), almost exclusively by trawl (Gulland 1971).

PLEURONECTIFORMES

Hippoglossoides platessoides American plaice
This species is the most important flatfish species in the region in terms of weight of catch. In 1981 90 000 tonnes were taken (FAO 1983). The main areas of commercial concentrations of this species lie in the southern Gulf of St. Lawrence, and on the shelf off Nova Scotia (FAO 1981). Most of the catch is taken by Canadian ships, but the U.S. takes around 10 000 tonnes from the Gulf of Maine also (FAO 1983, NOAA 1983). This species is found all along the continental shelf from Labrador to Rhode Island, chiefly in waters between 50 and 100 fathoms (90 - 182 m) (NOAA 1983), and adults may attain lengths of up to 80 cm (Pauly 1978).

Reinhardtius hippoglossoides Greenland halibut.
42 000 tonnes of this species were taken in 1981, most of which was taken by Canada (29 000 tonnes), with a small amount taken by Greenland (5 800 tonnes) and the rest taken by foreign ships (FAO 1983). This fish may attain lengths of more than 1 metre, and weights of more than 10 kg (Bowering and Brodie 1981). It is a slow growing species confined to colder waters of the North Pacific and Atlantic Oceans. The fishery in area 21 is pursued in the Davis Strait, and has increased rapidly since 1973 when only 9 000 tonnes were taken (Atkinson et al 1981).

Limanda ferruginea Yellowtail flounder.
Ranging from Labrador to Chesapeake Bay, and occurring in commercial quantities in a number of areas, Georges Bank, off southern New England and Cape Cod, and in Division 3NLO, to the east of Newfoundland. Adults may attain weights of up to 1kg, although much of the catch is of smaller individuals, and may be found in water 20 - 30 fathoms (37 - 73m) in depth (NOAA 1983). Total catch was 33 000 tonnes in 1981, of which the USA took 15 000 tonnes and Canada 17 000 (FAO 1983) with a fishing mortality in the US fishery in excess of 1.0 compared with an estimated Fmax of 0.5 (NOAA 1983). The fishery is conducted with both trawls and purse seines.

Pseudopleuronectes americanus Winter flounder.
Found from Labrador to Georgia along the North American coast, areas of peak abundance appear to be from Chesapeake Bay to the Gulf of St. Lawrence (NOAA 1983). Catches in 1981 were 23 000 tonnes, nearly all of which (19 000 tonnes) was taken by the U.S.A. (FAO 1983). The status of the stocks are unknown (NOAA 1983).

Glyptocephalus cynoglossus Witch flounder.
13 000 tonnes were taken in 1981, and catches have declined steadily over the preceding 6 years (FAO 1983). This species seems to prefer waters of more than 100m in depth and is most abundant in the areas around the Gulf of Maine. Adults may attain weights of around 2kg (NOAA 1983).

Other demersal species including Cusk (Brosme brosme) weakfish (Cynoscion spp.), roundnose grenadier (Coryphaenoides rupestris) are taken in smaller quantities (less than 10 000 tonnes per year), whilst a number of other species are taken in smaller quantities still.

PELAGIC FISH RESOURCES

In 1981 just over 0.5 million tonnes of pelagic fish resources were landed in the area. Almost all of the major pelagic stocks in this area have been heavily overfished. The bulk of the pelagic catch in this area is made up from just 4 species, but some other

species are also important economically, notably the Atlantic salmon.

CLUPEIDAE

Brevoortia tyrannus Menhaden.
The Atlantic menhaden has supported a fishery since the mid nineteenth century; catches peaked in the mid 1950's at around 700 000 tonnes and subsequently declined to under 200 000 tonnes in the late 1960's. Since then catches have been increasing again (Schaaf 1979). The catch in 1981 was recorded as 262 000 for area 21 although the total US catch including that from area 31 exceeded 400 000 tonnes (FAO 1983). The fishery is almost entirely pursued by purse seiners, and the catch is used for fishmeal (Reintjes et al 1978).

Clupea harengus Atlantic herring.
The total catch in 1981 was 224 000 tonnes, a considerable decline from catches in excess of 1 million tonnes in the late 1960's, stocks having been greatly overfished. Herring are found along the continental shelf from Labrador to Cape Hatteras, and are fished in at least 5 separate stocks from Newfoundland to the Gulf of Maine which is the area of their greatest abundance (NOAA 1983, Sissenwine and Waring 1979). The catch is taken almost entirely by Canada and the US and employs both fixed and mobile gear (NOAA 1983).

Mallotus villosus Capelin.
The offshore capelin fishery began in the early 1970's as an industrial fishery of a few thousand tonnes and was quickly expanded over the next few years. In 1976 more than 360 000 tonnes were taken and the offshore stocks were quickly depleted so that no offshore fishing was allowed in 1979 or 1980 (FAO 1983, Carscadden et al 1981). In the meanwhile the inshore fishery has expanded, so that the total catch in 1981 was recorded as 39 000 tonnes (FAO 1983). Some anxiety has been expressed over the state of the capelin stocks in relation to the feeding habits of harp seals, which are known to feed extensively on the capelin, and there is some evidence that the depletion of capelin may have affected the energetics of the harp seals (IUCN 1981).

SCOMBRIDAE

Scomber scombrus Atlantic mackerel.
The catch of this species in area 21 in 1976 was 242 000 tonnes, the next year this had dropped to 75 000 tonnes and currently (1981) the catch statistics show a catch of 28 000 tonnes (FAO 1983). Catches in the early 1970's were even higher, 420 000 tonnes in 1973, due to the intensive international fishery of that time and exceptional recruitment in the late 1960's. Most of the catch then was taken in ICNAF subarea 5 (off Cape Cod). By 1977 the number of countries participating in this fishery had been greatly reduced. The offshore fishery employs both purse seines and gill nets, whereas inshore small boat fisheries employ a great range of gear types, both fixed and mobile (Anderson and Paciorkowski 1980), some of which (set nets) are known to capture marine mammals incidentally (Gaskin 1983). The catch of mackerel is mostly divided amongst Canadian, US and Polish boats now, with the US taking less than 5000 tonnes (NOAA 1983).

SALMONIDAE

Salmo salar Atlantic salmon.
The Atlantic salmon is fished in the rivers and estuaries of a number of countries on both sides of the Atlantic. There are also important pelagic fisheries in feeding areas at sea, notably at West Greenland. Although catches in this region are usually only around 1 000 tonnes, and the total fishery for this species in the North West Atlantic is around 3 000 tonnes per annum, this represents an important fishery economically. Salmon at sea are taken largely by drift netting, and are taken along the coast upon their return to their native rivers to breed by a number of gear types, especially fixed nets. Drift nets are known to cause some mortality to small cetaceans, and pinnipeds are also seen by salmon fishermen as pests, either as vectors of parasites or as predators on salmon (Christensen and Lear 1974, IUCN 1981).

INVERTEBRATE RESOURCES

A number of species figure prominently in the catch statistics of this region. Gulland (1983) points out that scallops and clams are over-estimated because their weights include the shell, and that by far the most valuable species in more northerly waters is the deep water shrimp Pandalus borealis, which is trawled for in the Davis Strait; 45 000 tonnes were taken in 1981. The blue crab Callinectes sapidus is also an important commercial species locally in the Chesapeake Bay area, where over 50 000 tonnes were taken in 1981, mostly by traps set on long lines.

SQUIDS

Nearly 50 000 tonnes of squid were taken from area 21 in 1981 (FAO 1983). The two main commercial species are Loligo pealei and Illex illecebrosus, which are caught both by distant water foreign fleets at the edge of the continental shelf, and by local boats in inshore waters (NOAA 1983). Locally jigging appears to be the main method of catching squid (Voss 1973). Voss (1973) has noted the large numbers of squid eating marine mammals in this region and has agreed with Gulland (1971) that the resource may be very large.

THE FISHERIES OF AREA 21

Canada and the United States dominate the fisheries of this area, with catches of 1.16 and 1.24 million tonnes respectively for 1981. Greenland takes around 100 000 tonnes per annum, and a number of European countries also take some fish and squid in this area. Gulland (1983) has pointed out the importance of cod both historically and at present in the fisheries of this area, and indeed the Gadid family accounts for around 800 000 of the 2 800 000 tonnes of all species landed in 1981. Demersal fish accounted for 1 225 000 tonnes and pelagics around 500 000, the remainder being invertebrate.

A large portion of the total catch is therefore seen to be taken by trawling, the development of which is summarised by Gulland (1983). Purse seining is also important in pelagic fishing (see Pelagic Resources). These two methods of fishing appear to involve little interaction with marine mammals in this area.

Traditional fishing gear such as set nets, traps and weirs, and hand lines are still important in many of the coastal regions (Gulland 1983), and most of the species of fish mentioned above are also caught in inshore waters in such gear. These types of gear feature very prominently in the interactions with marine mammals as they seem particularly prone to incidental capture of, and often destruction by, marine mammals especially whales. Lien (1981) states that collisions between fishing gear and whales have increased over the past 10 years for a number of reasons, biological and economic, and that damages to gear and lost fish in 1979 and 1980 were equivalent to 2-3% of the total annual value of the inshore Newfoundland catch.

Gaskin (1983) amongst others has also stressed the importance of the introduction of monofilament gill nets in marine mammal entrapments. The number of fishermen fishing with such gear in Canada as suggested by survey work, far exceeded the number to whom licences have been supplied. This type of gear is, in Gaskin's opinion responsible for far more deaths to small cetaceans than other forms of gear.

To summarise, it would appear that whereas commercial trawling and purse seining equipment poses little threat of operational interaction with marine mammals or vice versa, coastal gear such as the traditional set net gears may be more prone to such conflicts. Similarly gill nets made from monofilament fibre feature prominently in gear conflicts with marine mammals. Large marine mammals such as baleen whales and in particular the humpback whales Megaptera novaeangliae, are most often implicated in coastal gear. Lien (1981) has estimated that humpbacks are responsible for 70-90% of such damage. Other species involved are Balaenoptera acutorostrata, Balaenoptera physalus, Eubalaena glacialis, Delphinapterus leucas, and Globicephala melaena. Not all such conflicts involve nets, and a number of entanglements have been reported between whales and crab pot lines and other forms of guy-line.

Amongst the smaller marine mammals gill netting is thought to cause most mortality; the species involved here include Phocaena phocaena, Lagenorhynchus acutus and Cystophora cristata, although humpbacks and other larger cetaceans are also very often caught in such gear.

Until recently biological interactions between marine mammals and fisheries in this area were not at all obvious. The recent expansion of many fisheries, both of traditional ones and the opening up of fisheries for relatively new species like capelin, has meant that such interactions have become more visible. At the same time many marine mammal species which were until recently at very low levels of abundance have started to increase once more. The reduction of capelin stocks, coupled with the recovery of the humpback whale population in area 21, has lead to the suggestion that the shortage of capelin may now be hindering further recovery of the humpback population (Whitehead 1982). At the same time the relative changes in the two populations may be a factor in the increase in gear damage in Newfoundland. The capelin shortage could also be affecting the harp seal population (IUCN 1981).

The expansion of fisheries into more northerly waters, such as the recent increase in catches of Greenland halibut and the shrimp Pandalus borealis could also create a new level of interaction with a number of marine mammal species which inhabit those waters and feed on such prey items, for example some of the seals and the narwhal and white whale.

The rapid expansion of the squid fishery should not go unmentioned either. The abundance of squid eating marine mammals in the area has been noted as an indicator of the abundance of squid. A number of these species, such as pothead or pilot whales and sperm whales may now be increasing in population size, so that conflict cannot be ruled out if the squid fishery continues to expand. Mercer (1975) has already pointed out that when peaks in pilot whale landings started to decline, peaks in squid catches increased. The reverse might therefore be expected as pilot whale abundance increases.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 21

The more obvious interactions in this area are principally operational in nature, despite the fact that this area is one of the most heavily fished in the world. This is partly due to the fact that the species which are caught do not overlap to such a great extent with the main food items of marine mammals in the area.

Operational interactions

Gear interactions are largely coastal ones involving small scale fisheries. Right whales, fin whales, minke whales, humpback whales, white-sided dolphins, harbour porpoises and hooded seals are all known to become entangled in a variety of gears, notably inshore set nets and traps.

Biological interactions

Grey seals are vectors of fish parasites which can cause considerable loss to the cod fishery in particular. Recently there has been the suggestion that biological interactions between marine mammals and fisheries may be becoming more important. Expansion of certain fisheries may impede the recovery of a number of marine mammal stocks. Harp seals and pilot whales in particular may be important potential competitors with fisheries.

3.3 AREA 27: NORTHEAST ATLANTIC

MARINE MAMMALS FOUND IN AREA 27

Eubalaena glacialis Right whale
The number of this species which remain in the North Atlantic is very small, perhaps only a few hundred. No interactions with fisheries are known or likely at present and no commercial fish species are eaten.

Balaena mysticetus Bowhead whale
Jonsgaard (1981) states that at most 9 animals have been sighted in this area in the last 23 years; the possibility of a breeding stock is therefore slight, and interactions with fisheries are also unlikely.

Balaenoptera physalus Fin whale
The population size in the north east Atlantic is unknown, but may be in the thousands. This species like other baleen whales is depleted, but unlike some others is known to feed on commercial fish species (Tomilin 1967), such as herring and capelin, stocks of both of which are at present heavily exploited in the area. The possibility that the fishery may therefore affect the recovery of fin whale stocks cannot be excluded.

Balaenoptera musculus Blue whale
Presently also at very low levels of abundance; 245 sightings of 462 blue whales were reported by Icelandic whaling vessels in the summer 1982 whaling season (IWC SC/35/Prog. Rep. Iceland 1983). This species does not feed on fish, and is unlikely to be affected by commercial fisheries.

Balaenoptera acutorostrata Minke whale
The minke whale has been well known as a fish eater, especially of herring, for several centuries at least (Von Brandt 1972). Jonsgaard (1982) amongst others has also noted a number of commercial species eaten by the minke whale, including cod. The minke whale may be less abundant now than in former years, as are a number of its food species, in area 27, which may be bringing it into closer conflict with several fisheries, notably those for capelin, herring and cod. As yet however, little has been reported on the matter.

Balaenoptera borealis Sei whale
The sei whale population size in area 27 is unknown, but depleted, presumably numbering no more than a few thousand. Fish are not an important part of the diet, however, so it may be that this species does not interact with any fishery.

Megaptera novaeangliae Humpback whale
The report of the Sub-committee on Protected Species and Aboriginal Whaling (IWC 1982) suggests that this stock spends the winter in the Caribbean region, whilst stating that some animals have been seen in the Azores in the past. No population estimate is available; however, this is unlikely to be more than a few thousand. The diet of this whale is known to include fish species, such as capelin, (Tomilin 1967) for which there is an intensive fishery in the north eastern parts of area 27. The possibility of this fishery affecting the rate of recovery of the population of humpbacks in area 27 cannot therefore be overlooked.

Mesoplodon bidens Sowerby's beaked whale.
Very rarely seen, there is little likelihood of this deepwater squid eating species interacting with any commercial fisheries at present.

Mesoplodon europaeus Gervais' beaked whale.
Occasionally straggling into European waters on the Gulf Stream, this is another deep-water species, unlikely to come into contact with any fisheries.

Mesoplodon grayi Gray's beaked whale.
This species too is rarely seen and deepwater in habitat.

Mesoplodon mirus True's beaked whale.
As with the other Mesoplodon species this one is rare and unlikely to conflict with fisheries.

Ziphius cavirostris Cuvier's beaked whale.
Rarely seen, this species feeds on squid and is unlikely to be involved in any interaction with fisheries at present.

Hyperoodon ampullatus Northern bottlenose whale
Mitchell (1977) has provided evidence that the population is at present depleted after decades of hunting in the North Atlantic. The bottlenose whale prefers deeper water,

feeds on squid and is unlikely to interact with fisheries, unless squid stocks are to become heavily exploited.

Physter macrocephalus Sperm whale
Townsend's maps show the main areas of sperm whale distribution around the Azores, where there was and still is a whaling industry based on this species (see e.g. Clarke 1981). The population in the North East Atlantic is unknown but may be presumed to be in the thousands. The report of the Sub-committee on Sperm Whales (IWC 1982) gives an estimate of 58 000 for the stock exploited by Icelandic whales. As with other mainly squid eating species, no interaction with fisheries is likely unless an intensive squid fishery is developed.

Kogia breviceps Pygmy sperm whale
Duguy (1977) refers to this species as unusual in French waters, and although Clarke (1981) records it as present in the Azores it is not common there either. Nothing is known of the size of the population, and as the diet is also not clear, there is nothing that can be surmised about interactions with fisheries.

Monodon monoceros Narwhal
Known to eat commercial fish species (Tomilin 1967), the population size in area 27 is unknown, but may still be severely reduced (Tomilin 1967). This again brings up the possibility of some interaction with commercial fisheries for food species, although Tomilin suggests the main diet in those areas is pelagic squid.

Delphinapterus leucas White whale
Bjorge et al (1981) have noted the fish eating habits of this species which apparently has also annoyed local fishermen on at least one occasion in Finnmark, Norway, after an 'aberrant migration' into that area. Tomilin (1967) describes it as widespread in cold coastal waters, and the Report of the Sub-Committee on Small Cetaceans (IWC 1982) gives figures of 232 and 1 570 as minimum and maximum counts of white whales in the Barents, Kara and White Seas. Tomilin also records a number of commercial fish species in the diet, including salmon, so there is at least the potential for conflict.

Steno bredanensis Rough-toothed dolphin
Duguy (1977) does not record this species in French waters, and Clarke (1981) does not record it in the Azores either. Hershkovitz (1966), however, records the distribution of this species as from the Netherlands to Portugal. It is presumably rare in this area, and as its diet here is also unknown, the likelihood of interaction with fisheries cannot be assessed.

Pseudorca crassidens False killer whale
Apparently not a common species in this area, and one without recorded interactions with fisheries here either. Given its pelagic and oceanic habits the chances of interaction seem small, although in other areas commercial fish are eaten.

Orcinus orca Killer whale
There have been a number of suggestions that killer whales may be deleterious to fish stocks, particularly the herring stocks around Norway (see Hiby and Harwood 1981), but theoretical analysis by Hiby and Harwood has shown that killer whales do not necessarily affect the dynamics of herring. There is no doubt, however that this species is seen as a nuisance by some fishermen at least. Christensen (1982) also records the fact that fishermen off Iceland have found killer whales to be such a nuisance in fishing for halibut that at times they have had to abandon the fishing. Mitchell (1975a) writes that killer whales in Icelandic coastal waters were perceived as such a threat that the U.S. Navy was asked to get rid of them. Hundreds were killed this way in the 1950's. There are no population estimates for area 27, but this species is certainly not rare, at least in colder coastal waters.

Globicephala melaena Long-finned pilot whale.
This species occasionally turns up in fishing nets as an incidental catch in area 27. Duguy and Hussenot (1982) give details of 5 such incidental captures on the French Atlantic coast between 1971 and 1981, 3 in bottom or midwater trawls, and 2 in gill nets. There has also been a certain amount of exploitation of this species, notably in the

Faroe Islands, where over 1 000 are taken a year. The population size is unknown but presumed stable, and may number in the hundreds of thousands. The food is chiefly squid (Sergeant 1962) although fish may also be eaten.

Globicephala macrorhynchus Short-finned pilot whale.
Clarke (1981) records this species from the Azores, although it is not apparently common, and does not occur much further north than this. Interactions with fisheries are therefore unlikely.

Lagenorhynchus albirostris White-beaked dolphin.
This species is known to feed on commercial fish, including cod, whiting and herring (Tomilin 1967). According to Tomilin it is most common in the North Sea especially up to Norway and the eastern coast of Britain. Aguayo (1978) considered it to be one of the 'normal inhabitants' of the Baltic. Leatherwood and Reeves (1983) state that a few are taken accidentally each year in trawl nets in the North Sea. The occurrence of a number of commercial fish species in the diet may indicate some degree of competition for food resources.

Lagenorhynchus acutus Atlantic white-sided dolphin
Also known to eat commercial fish species, the population size of this species is unknown, but Tomilin (1967) states that it enters Norwegian fjiords in vast numbers in pursuit of herring. It has also been recorded in the Baltic, but Aguayo (1978) suggests that it may be rare there.

Tursiops truncatus Bottlenose dolphin
Incidental catches of this species are reported by Duguy (1977) and Duguy and Hussenot (1982) who state that 3 have been taken in mid or deep water trawls on the French Atlantic coast in the 10 years 1971-1981. Duguy (1977) says this species is widespread but not common, and Aguayo (1978) suggests that it may be a regular visitor to the Baltic. The population size is unknown, and the diet in this area has received little attention, but presumably includes some commercial species. Interactions with fisheries are probably more widespread than reported for this species.

Grampus griseus Risso's dolphin
This species is also incidentally caught in nets on occasion. Duguy and Hussenot (1982) report 2 found in gill nets from 1971 to 1981 along the French Atlantic coast. Clarke (1981) suggests that this species is common in the Azores, whereas Aguayo (1978) states that it only visits the Baltic on rare occasions. The diet is chiefly squid, and so apart from the occasional net entanglement, there seems little likelihood of any interaction with fisheries at present.

Stenella coeruleoalba Striped dolphin
This species is yet another which is infrequently found in nets as an incidental capture. Duguy and Hussenot (1982) report 2 in gill nets on the Atlantic French coast, but also state that several thousand of this species and the common dolphin may have been killed in the ten year period 1971-1981, by French fishermen at sea, for food. The effect of this on the population is unknown. Diet in this area is unclear, as are any other potential interactions with fisheries.

Delphinus delphis Common dolphin
Duguy and Hussenot (1982) report 25 individuals of this species being captured between 1971 and 1981; 2 on shark longlines, 8 in gill nets and 15 in trawls. Collet (1983) also records 16 confirmed incidental captures in French Atlantic coastal fisheries in 1981. This species is known to eat sprats, sardines and anchovies off the coast of France (Tomilin 1967). It is probably also caught regularly elsewhere, but does not seem to be reported as such. Duguy (1977) states that it is the most common small cetacean on the Atlantic French coast, and adds that large numbers of this species are taken by French fishermen whilst at sea as fresh meat for the boat crews. The effect of this on the population is unknown, as is the extent of the interaction between this species and fisheries which operate on its food species.

Phocoena phocoena Harbour porpoise
Andersen and Clausen (1983) have suggested that a considerable number of this species,

possibly hundreds per year may be taken in Danish trawl nets. Gaskin (1983) gives data on the numbers of this species stranded in Scottish nets. Up to 24 have been taken in a year, mostly in set nets which fish for cod. Gaskin also cites numerous other authors' opinions that this species may be becoming rarer in area 27, although Easton et al (1982) suggest otherwise on the basis of British stranding records. Aguayo (1978) suggests that this species is one of the 'normal inhabitants' of the Baltic, but gives some indication that it may now be much rarer there than in previous years. The population size is unknown, and the extent of interaction with fisheries is also unclear, but there is certainly some by-catch, and presumably some overlap in the fish species taken. Tomilin (1967) includes herring, capelin, mackerel, sardine, cod, Baltic cod, whiting, eel, small salmonids, and sole in the diet of this species for the Atlantic.

Odobenus rosmarus Walrus
The population in area 27 is confined to two regions, around Spitsbergen and Novaya Zemlya, and probably numbers no more than a few hundred (Fay 1981). There is no apparent conflict with fisheries at present, and none likely unless a mollusc fishery is developed in these waters.

Phoca vitulina Harbour seal
Known to eat commercial species of fish, especially in shallow or inshore waters, the population in the north east Atlantic may total about 50 000. Between 6 and 8 000 individuals are apparently killed by hunting every year in area 27 (Bonner 1979c), mostly in Iceland. The population in the Baltic is currently at a critically low level, with perhaps only 150 animals left (Almkvist 1977); there are also said to be complaints from fishermen in the Baltic with regard to this seal (Almkvist 1977). There does not appear to be any data on incidental catches, but it is clear that as a result of the diet of this species there is competition with fisheries in a number of places (Bigg 1981).

Phoca hispida Ringed seal
One of the two main pinniped inhabitants of the Baltic, this species is otherwise confined to the more northerly regions of area 27, in the Barents Sea (Frost and Lowry 1981). It is also said to be the most abundant seal in the Arctic with a total population of 6-7 million; there is a harvest in the White Sea of 3 500 annually (Stirling and Calvert 1979). Stenman (1978) suggests that the ringed seal is responsible for damage to salmon fisheries in the Baltic, but this is the only area where such interactions are recorded, although the diet may include some commercial species (Frost and Lowry 1981).

Phoca groenlandica Harp seal.
Although most numerous in area 21, there are sizeable populations in area 27 also. The population in the Barents Sea has come into serious conflict with fishermen in northern Norway recently. In the years from 1978 to 1981 large numbers of these seals migrated south to feed on capelin which migrates to the coast of Norway. Bjorge et al (1981) state that as many as 10 000 harp seals may subsequently have drowned in cod set nets for each of these years, causing millions of kroner damage to nets and catch. Oritsland (pers. comm.) reports that invasions of the coast of Finnmark by large numbers of harp seals have continued in 1982, 1983 and 1984.

Erignathus barbatus Bearded seal.
Burns (1981) cites Chapskii's (1966) estimate of 300 000 for the entire North Atlantic, this species is confined to more northerly regions and feeds on benthic organisms. At present there are no apparent interactions with fisheries, and none would seem likely.

Cystophora cristata Hooded seal
Distributed around Jan Meyen Island and as far east as Bear Island, the population size in this area is unknown, but may be in the hundreds of thousands (Reeves and Ling 1981). Sergeant (1976 cited in Reeves and Ling) has suggested redfish may be an important part of the diet, in which case some competition with fisheries may occur. Oritsland (pers. comm.) reports that some hooded seals are taken on longlines and in driftnets set for salmon off the coast of northern Norway, although damage to fish and gear is apparently of minor importance.

Halichoerus grypus Grey seal
The population of this species is estimated at around 100 000 individuals in area 27,

very few of which remain in the Baltic. The species is commonly found feeding inshore and is continuously in conflict with fishermen due to the damage it causes to nets, especially set nets, and catch, especially salmon. Stenman (1978) gives details for the Baltic, where around 2% of the salmon catch is said to be damaged by grey seals. Grey seals are also a nuisance in Scotland and Norway (ICES 1981), and it has been suggested may cause serious loss to the fishing industries of such countries as quite a number of commercial species are known to be included in the diet. (Parrish and Shearer 1978, ICES 1981). Recent work by the Sea Mammal Research Unit in the UK has suggested that this effect may have been overestimated as much of the grey seal diet may consist of small less valuable fish such as sand eels (NCC 1984). The Sea Mammal Research Unit have examined seal faeces from 9 haulout sites around the British Isles. Their results indicate that, overall, 60% of the diet of British grey seals is made up of sand eels (Ammodytes), 12.4% was tusk and ling (Brosme brosme and Molva molva), 6.7% Trisopterus, 6.3% whiting (Merlangius merlangius), 5.8% flatfish, 5.1% haddock saithe and pollack, 3% cod, and less than 1% blue whiting, blenny, goby, herring, sprat and horsemackerel.

There is also the problem that grey seals are known to be hosts for the fish parasite Phoconoema decipiens (IUCN 1981) which also causes losses to the fishing industry. This may be a particular problem locally, and has even been the reason for some culling of grey seals (Bonner 1981a).

Monachus monachus Mediterranean monk seal
Sergeant et al (1978) record a few isolated sightings of this species at the Azores, but there is probably no breeding population there and the numbers of animals involved probably precludes any appreciable interaction with fisheries in this area.

Interactions between marine mammals and fisheries are comparatively well documented in area 27, and yet it is apparent that for a number of species, such as the harbour porpoise, common dolphin and harbour seal, the extent of interaction remains unclear. Of the 36 species described above, at least 17 are known to eat commercial fish species. A further 8 or 9 are thought to feed primarily on squid. The extent of fishing operations in area 27 is such that almost any marine mammal which is known to eat commercial fish species will compete to some degree with a fishery. Similarly there are probably few species, perhaps only the very rarely recorded ones, which are not likely to become incidentally captured in fishing operations in some part of the area.

Fortunately, incidental captures in this area do not seem to involve very large numbers of animals, the exception perhaps being provided by Andersen and Clausen's (1983) account of the harbour porpoise in Danish trawl nets, and the unusual catches of harp seals in recent years in northern Norway.

As might be expected in an area which is both heavily fished and has a large number of feeding marine mammal species there are a comparatively large number of recorded 'competitive' conflicts between marine mammals and fisheries.

THE FISH STOCKS OF AREA 27

DEMERSAL FISH RESOURCES

Catches of demersal species in 1981 totalled 5 469 846 tonnes (FAO 1983). As with the northwest Atlantic, the main commercial species are flatfish, especially the plaice, and the gadid family especially cod. The commercial fisheries of this region are amongst the oldest in the world and many of the modern fishing methods were first developed in this region; perhaps as a result of this many of the stocks in this region are fully or over-exploited. The region remains however the second most productive in the world after area 61.

GADIDAE

Gadus morhua Atlantic cod
This species is perhaps the most important of all in this region and has been fished for

from European shores for many hundreds of years. There are numerous stocks, scattered from the English channel through the North Sea to the Baltic in the east to Iceland in the west and to the Barents Sea in the north. Many of these stocks are probably over exploited as the reports of the ICES working groups on roundfish demonstrate. In the North Sea for example the stock has been declining whilst catches have remained stable; the fishing mortality has increased to around 1.0, whereas Fmax may be around 0.25. Similarly in division 6a, to the west of Scotland the current fishing mortality far exceeds the value of Fmax.

In most areas cod is trawled for, although in the North Sea the Danish seine is also used for this and other species of demersal fish (Gulland 1983) as an effective alternative to trawling. In a number of areas more traditional methods employing stake nets, lines, gill nets, etc. are still used. Bjorge et al (1981) refer to set nets in northern Norway for the entrapment of cod, and Gaskin (1983) also refers to stake nets for cod, trapping harbour porpoises in Scotland. The total catch of cod in area 27 exceeded 1.7 million tonnes in 1981.

Micromesistius poutassou Blue whiting
This species produces the next largest catch after cod of the demersal species in area 27. 870 000 tonnes were taken in 1981 whereas over one million were taken in each of the two preceding years. The main spawning area is to the west and north of Scotland, ranging from off the coast of southwest Ireland up to the area between the Faroe Islands and the Orkneys. Ranging as an adult from the Mediterranean to Spitzbergen, the species was until recently only very lightly exploited. It is found during the spawning season at several hundred metres depth over the edge of the continental shelf, and as it is too dispersed for much of the rest of the year this is where most of the fishing effort is concentrated. The fishery is pursued mostly by large trawlers (over 40m in length) with the use of single mid water trawls, and occasionally high headline bottom trawls where the fish are close to the shelf edge (Pawson 1979).

Pollachius virens Saithe
Mainly distributed to the west of the British Isles, in the northern North Sea, and around the Faroes, Iceland and Norway. In 1981 this species yielded over 420 000 tonnes, from at least 5 stocks identified by the ICES Saithe working group. The fishery is mostly pursued by trawlers, although there is a significant purse seine fishery for the juveniles in the North Sea and off Norway, carried out mostly by Norwegian ships.

Trisopterus esmarkii Norway pout.
This is one of the so called industrial fish, used solely for reduction to meal and oil which has only recently been exploited. It is a small fish, usually found within a few metres of the sea bed in water 100 to 250 metres deep. The fish is confined to the northern North Sea and the adjacent areas, and appears to be caught mostly by Danish trawlers. The catch has declined from a peak of over 800 000 tonnes in 1974, but the status of the stock is far from clear as recruitment appears to be highly variable.

Melanogrammus aeglefinus Haddock
This species has a similar though less extensive distribution to cod. It has apparently been over exploited in the North Sea and to the west of Scotland, but catches around the Faroes have remained more stable. Total catches of this species were 333 000 tonnes in 1981, up on 1980, but below the level of the early 1970's when more than 500 000 tonnes were being caught annually. The fishery is mainly pursued by trawling, although Gulland (1983) points out the North Sea Danish seine fishery for this and other species.

Merlangius merlangius Whiting
Total catches of this species in 1981 were 189 000 tonnes, and have been fairly stable for the last 5 years, but are lower than catches in the mid seventies which exceeded 250 000 tonnes (FAO 1983, 1977). This species is largely confined to the waters around the British Isles, with small spawning grounds and populations centred on the Faroe Islands and southwest Iceland. The population appears to be fully exploited at present.

SCORPAENIDAE

Sebastes spp. Redfish
Deepwater slow growing fish, these species are mainly found in northerly waters from south of Greenland to the Barents Sea. The annual catch in 1981 was 250 000 tonnes.

AMMODYTIDAE

Ammodytes spp. Sandeels
The main species in this fishery is A. marinus, which is distributed in commercial quantities around the British Isles, in the North Sea and along the coast of Norway. Adults are most abundant at depths of between 20 and 40 metres in the northern North Sea, although in recent years deeper waters have also been exploited successfully. Catches increased to a peak in 1978 of 800 000 tonnes, and have since decreased to 630 000 tonnes in 1981. 66% of landings in 1978 came from the Dogger Bank in the northern North Sea. There is still considerable uncertainty as to the status of this stock. Most of the catch is taken by Danish trawlers.

PLEURONECTIDAE

Pleuronectes platessa Plaice
This species has been exploited for a long time and was one of the first to be fished for with trawls in the North Sea. Catches have been relatively stable, around 150 000 for a number of years, but most stocks have been heavily exploited. The fishing mortality on the North Sea stock is thought to be well in excess of Fmax. This species is mostly fished for by trawl and by Danish seines.

OTHER SPECIES

The species mentioned above all yielded more than 100 000 tonnes in 1981. A number of other stocks however yield catches in excess of 10 000 tonnes, which in an area less productive than this would constitute a major commercial yield. Amongst the gadoids, hake and ling (Merluccius merluccius and Molva molva) yielded 77 and 58 thousand tonnes respectively in 1981. The sole Solea solea yielded 25 000 tonnes which is an important catch economically, and the monkfish or anglerfish (Lophius piscatorius) also yielded a sizeable catch in 1981 of 49 000 tonnes.

PELAGIC FISH RESOURCES

Some 5 million tonnes of pelagic fish were taken in 1981. Of this total over half consists of capelin, largely used for reduction to meal and oil, which has replaced herring as the most important species by weight. Many herring stocks have collapsed through overfishing, and are now at a low level. Most other pelagic species are probably fully exploited.

OSMERIDAE

Mallotus villosus Capelin
The capelin stocks of Iceland, northern Norway and the Barents Sea have only been exploited since the 1960's, since when catches have risen to a peak of 3.7 million tonnes in 1977, and have since dropped off slightly. The fishery is largely pursued by Icelandic, Soviet and Norwegian boats using purse seines. Gulland (1983) states that the stocks appear to be in a reasonably healthy state.

CLUPEIDAE

Clupea harengus Atlantic herring
Once one of the two most important fish species in the northeast Atlantic, the herring has been overfished to such an extent that recruitment in a number of places has all but disappeared. Herring has been and still is fished for in a number of ways, but perhaps most effectively by the purse seine. Catch quotas on most stocks have been greatly reduced, in some cases to zero, and there are signs of recovery in some areas.

Sprattus sprattus Sprat
One of a number of 'industrial' fish taken in large quantities (238 000 tonnes in 1981) chiefly by Danish boats using trawls, in coastal waters around the North Sea and in the Baltic. There has been some debate as to the effect this fishery may be having on the recovery of the North Sea stocks of the herring, as considerable quantities of herring are also taken as by-catch by this fishery.

Sardina pilchardus Sardine
A more southerly species, taken in the coastal waters off France Spain and Portugal, with a catch in 1981 of over 500 000 tonnes. Most of this catch was taken by Portuguese and Spanish boats, the majority of which are small inshore vessels under 50 GRT (Agra Europe 1981).

CARANGIDAE

Trachurus trachurus Horse mackerel
156 000 tonnes were taken in the southern region of area 21 in 1981, which is a decrease from the early 1970's, when over 300 000 tonnes were taken.

SCOMBRIDAE

Scomber scombrus Mackerel
About 575 000 tonnes were taken in 1981, from 2 stocks, one in the North Sea and one to the west of Britain. ICES working group reports reveal that both of these stocks are over exploited, and it seems doubtful that the North Sea can continue to support the size of fishery that it currently does. Mackerel are taken in a variety of ways, most effectively perhaps by purse seining, but in some areas such as south west England, hand-lining is also used.

Other important pelagic fish stocks include the anchovy (29 000 tonnes) in the southern region, and a number of tuna species which although they do not support a great weight of catch are nevertheless important commercially. Albacore Thunnus alalunga is the most productive tuna species, with 28 000 tonnes taken in 1981. Salmon too should be mentioned particularly as it is still taken in traditional set net along coasts of Scotland and Scandinavia, where there is sometimes considerable antagonism between salmon fishermen and grey seals which frequently visit salmon nets, damaging gear and catch.

INVERTEBRATE RESOURCES

CRUSTACEA

A number of species are commercially important notably Cancer pagurus, the edible crab, Pandalus borealis, the northern prawn, Nephrops norvegicus the Norway lobster, and Crangon crangon the common shrimp. These species are taken in a number of ways. The northern prawn is trawled for by Danish boats in the Kattegat and Skagerak, and by other trawlers further north also (54 000 tonnes in 1981). The common shrimp (40 000 tonnes) is taken particularly in sandy estuaries around the North Sea often with special shrimp nets. (Holthuis 1980).

MOLLUSCA

Cockles (Cardium edule), mussels (Mytilus edulis), scallops (Pecten maximus), and oysters (Crassostrea spp.) are all important locally, and are mostly harvested in a small scale manner, often by hand.

CEPHALOPODA

Squid forms a remarkably small part of the total catch in this area, around 35 000 tonnes in 1981 or 0.2% of the total yield of all species. A further 15 000 tonnes of octopus were taken. Voss (1973) states that most of the squid catch is incidental to trawl fisheries for finfish, and that the total potential for the northeast Atlantic is much greater than current catches.

THE FISHERIES OF AREA 27

This area is one of the most productive in the world with a total production of over 11.6 million tonnes in 1981, it ranks second after the Northwest Pacific. Gulland (1983) divides the area into 4 major subregions, which are the northern region from Greenland to Iceland and north Norway and Russia, the Baltic Sea, the area around the British Isles including the North Sea, and the southern region from Ushant to Gibralter.

Gulland suggests that the proximity of markets coupled with the high productivity of the area has been responsible for the early and sustained development of fisheries here. Each of Gulland's subregions has a group of fish which are locally important. So in the north, cod and, until recently, herring were the most important. Now redfish, haddock, and most notably capelin have also become important. Further south a larger number of species, cod, herring, mackerel, sole, plaice, whiting and haddock have all been important, and still are, but Norway pout, sand eel, sprat and blue whiting are added to the list in recent years. In the Baltic, again cod and herring are important, the latter species having played an important role in the economy of the Baltic historically (Cushing 1982). Sprat is the other important fish in the Baltic, though in recent years catches there have declined as the numbers of sprats has declined dramatically. In the southern region, sardines, hake and sea breams replace the northern species in importance.

The productivity of the region, together with its complex political and geographical structure makes any simple unravelling of the fisheries very difficult. Norway has the largest catch in this area of more than 2.5 million tonnes in 1981 most of which was capelin (1.3 million tonnes). The Soviet Union, Iceland and Denmark all also took more than 1 million tonnes in 1981. After this the UK, France, the Federal Republic of Germany, the Netherlands and Spain are all important in terms of total catch.

The fishing methods of area 27 are dominated by the trawl and purse seine both of which were developed in this area, but Gulland (1983) points out that these two methods have not totally eclipsed the older fishing techniques. Danish seines are still used in the North Sea, and set nets are also still used in a number of places. Gill nets are still used in Norway and Iceland to catch spawning cod. Traps and shrimp nets are also used in the capture of crustacean species. The region therefore contains a rich mixture of ancient and modern methods of fishing, maintained by a number of economic, social and geographical factors.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 27

There are numerous reports of incidental captures in this area involving small cetaceans in particular. Many of these are reported to the Small Cetacean Sub-Committee of the IWC.

Operational interactions

1 Common dolphins and harbour porpoises are commonly caught in European waters in a variety of gears including trawls.

2 Harp seals have been taken incidentally in cod nets in large numbers in northern Norway.

3 Striped, Risso's and bottlenose dolphins as well as pilot whales and some seal species are all occasionally caught in trawl and gill nets.

It is noticeable that in contrast to area 21 few if any large cetaceans are recorded as having been captured incidentally. This may be because of different fishing methods, or else the baleen whales in this area feed in areas where set nets and other forms of gear in which they may be prone to become trapped, may not be used.

Biological interactions

Competitive interactions in this area as elsewhere are difficult to ascertain. Nevertheless it would seem that a number of species of marine mammal could well be in direct competition with commercial fisheries at present. These include the fin and humpback whales currently recovering from over exploitation and feeding on heavily exploited fish stocks. Other species may not be depleted to the same degree, but may still be affected by commercial fisheries. On the other hand in two cases where fisheries were thought to be suffering from competition with marine mammals, it has been suggested that the effects may not be as serious as had been claimed. The killer whales in Norway were claimed to be affecting herring stock recovery, but Hiby and Harwood (1981) in a theoretical analysis have shown that this need not be necessarily so. Similarly, the effects of grey seals on salmon fisheries have also been shown to be less dramatic than had been claimed (Stenman 1978, NERC 1984), although locally they are still often regared as a serious pest.

3.4 AREA 31: WESTERN CENTRAL ATLANTIC

MARINE MAMMALS FOUND IN AREA 31

Eubalaena glacialis Right whale
Tomilin (1967) records the right whale from Bermuda, and Moore (1953) lists it as one of Florida's marine mammals. Feeding is presumably concentrated in the summer and to the north of its range. No interaction with fisheries is therefore likely in area 31. The population in the western Atlantic is unknown, but unlikely to be more than a few hundred.

Balaenoptera physalus Fin whale
Tomilin (1967) states that this species is rare in the tropics, whilst Jonsgaard (1966a) states that it occurs as far south as 29°N off Florida. Interactions are unlikely in area 31 as this species is hardly ever seen there, and feeds mostly in more nothern regions. (Tomilin 1967).

Balaenoptera musculus Blue whale
The southerly limit of the winter migrations of the Atlantic stock are unknown, but Jonsgaard (1966a) states that this is at least as far south as Atlantic city. Numbering only a few hundred in the North Atlantic, at most, this species represents no threat to fisheries at present, eating only pelagic crustacea, principally Thysanoessa inermis, in the North Atlantic, and according to Tomilin (1967), no fish.

Balaenoptera acutorostrata Minke whale
Rarely recorded in area 31, Moore and Palmer (1955) state that at least 4 are recorded as having stranded in Florida until then, as far south as 25°N. Although the most Ichthyopagous of baleen whales, there can be little chance of any interaction with fisheries in area 31, due to their scarcity in this region.

Balaenoptera borealis Sei whale
Jonsgaard (1966a) reports them as far south as Mexico and Florida, and Erdman et al (1973) also report this species from the north east Caribbean, Mead (1977) provides a comprehensive list of records of this species in the area. According to Tomilin (1967) they are known to eat fish, but are best adapted to eat small pelagic crustacea, notably

Calanus spp. in the North Atlantic. Although more warmth loving than B. physalus, they are still seen only very infrequently in area 31 and hence are unlikely to interact with fisheries.

Balaenoptera edeni Bryde's whale
A more tropical whale than other baleen species; Jonsgaard (1966a) reports this species was caught in Grenada in the 1920's. Hershkovitz (1966) also reports it from the Caribbean, and Payne (1979) from the Gulf of Mexico; it is, however, missing in Moore's (1953) list of species in Florida. Gambell (1977) suggests there may be a resident population in the area. The population size is unknown, but as the food is known to include commercial fish species elsewhere, some degree of competition with fisheries may occur here.

Megaptera novaeangliae Humpback whale
This species regularly migrates to the Caribbean, to a number of breeding sites in the winter (as far south as Grenada). Hunted there by Yankee whalers in the last century, (Townsend 1937) this practice is continued on a very small scale by whalers in Grenada, though, this fishery appears to be dying out, (Caldwell & Caldwell 1975). Winn et al (1975) estimate the population in the Caribbean at between 785 and 1157, a great increase in the last 60 years. Humpbacks do not appear to feed in the winter or at least only to a very small extent (see eg. Mackintosh 1965 and Chittleborough 1965), so no interaction is likely with fisheries.

Mesoplodon densirostris Blainville's beaked whale
Again, according to Moore (1966) this species may inhabit the central southern North Atlantic, straying to North America. Gunter (1955) records a specimen stranded in Padre Island, Texas, in 1946 and Caldwell and Caldwell (1971b) record one from Florida. Moore (1958: not seen) also records one from the Bahamas.

Mesoplodon europeaus Gervais' beaked whale
According to Moore (1966), this species probably inhabits the Antillean region and the Gulf of Mexico, straying northward along the Gulf Stream. Rankin (1953) reported 2 specimens from Jamaica, and according to Leatherwood and Reeves (1983) others have stranded in Florida, Texas, Cuba and Trinidad. No feeding data is available, but they are assumed to feed on squid.

Mesoplodon mirus True's beaked whale
Another deepwater species, which, according to Moore (1966), inhabits areas off the continental shelf of North America in the mid-Atlantic; it does not apparently stray into the Caribbean region, but has occasionally been stranded on the Atlantic coast of the United States. As with other beaked whales, squid is presumed to form the bulk of the diet.

Ziphius cavirostris Cuvier's beaked whale
Recorded throughout the area. Erdman (1962) reports one specimen from Puerto Rico, and cites Aguayo for another in Cuba. Moore (1953) lists it as present in Florida, and Erdman et al (1973) confirm its presence in the north east Caribbean. Caldwell et al (1971a) also record its capture in the St Vincent small whale fishery, and Caldwell et al (1971) report the species from Georgia and South Carolina. Despite this, like all other beaked whales, this species is not common, and according to Tomilin (1967) is normally found pelagically, although the number of strandings indicate that it does wander closer to shore. Erdman's (1962) specimen in Puerto Rico contained squid remains only, although Leatherwood and Reeves (1983) state that it also eats deepwater fish.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps of the distribution of sperm whales clearly show enormous feeding grounds in the central Atlantic, and to a slightly lesser extent in the eastern Atlantic. Both of these grounds extend into the northern regions of area 31, and there are numerous other reports dotted around the Caribbean, West Indies and out to the "twelve forty" ground, centred at 12°N, 40°W. Taruski and Winn (1976) report sperm whales from Grenada to the Caicos banks in water deeper than 100 fathoms. Caldwell et al (1971a) noted that from October to March sperm whales might be caught in the St Vincent fishery. Erdman et al (1973) confirm the relative scarcity of sperm whales in the north east Caribbean in the summer. The sperm whale, according to Tomilin (1967), amongst many other, is essen-

tially a squid eater, and so presumably any seasonal distribution is linked to squid availability. No estimates of the numbers of sperm whales in the area are available, but a figure in the thousands of animals at least visiting the area would not seem unreasonable. There has not been any interaction with fisheries, and unless a squid fishery is developed none seem likely in this area.

Kogia breviceps Pygmy sperm whale
Moore (1953), Gunter et al (1955) and Caldwell et al (1971) all attest to the presence of this species in the south eastern United States, yet there appears to be no evidence of its presence elsewhere in area 31. This is probably an artefact of its rarity. Tomilin (1967) states that it feeds principally on squid, although other items have been found in stomachs. No interaction is known nor seems likely.

Kogia simus Dwarf sperm whale
Probably even rarer than the preceding species and apparently recorded only from the eastern seaboard of the U.S. (Caldwell et al 1971), this species, like the last, is thought to feed on squid. No interactions are likely for the same reasons as above.

Steno bredanensis Rough-toothed dolphin
Recorded from Georgia, USA (Richardson 1973), Florida (Moore 1953) and also found in the St Vincent fishery by Caldwell et al (1971a). Payne (1979) also records 3 stranding incidents in the Gulf of Mexico, one involving 16 animals which were shown to have fed on pelagic octopi. These appear to be the only records of this animal. Once again interactions are unknown and unlikely due to its rarity and the absence of intensive cephalopod fisheries.

Sotalia fluviatilis Tucuxi
Found in the river systems of Venezuela and Guiana, and in the shallow seas around the coast of north eastern South America. They feed on catfish, other fresh water fish and crustaceans (Mitchell 1975). Bruyns (1971) cited in Mitchell (1975a) states that they are held in high esteem and are not hunted, but Best and da Silva (1984 in press) record the frequent incidental capture of this species in the Amazon. Presumably such captures occur in other parts of the range also. The population size is unknown.

Peponocephala electra Melonheaded whale
Only rarely recorded in area 31 this is an uncommon species worldwide. Caldwell et al (1976) found it in St Vincent, where they discovered fish otoliths, squid beaks, two isopods, and a very large red shrimp. No interaction with fisheries is known or likely.

Feresa attenuata Pygmy killer whale
Caldwell and Caldwell (1971a) record the first Caribbean occurrence of this species in the St Vincent fishery. James et al (1970) also report the first record from the Gulf of Mexico, and refer to another in Costa Rica, while Caldwell and Caldwell (1975a) describe a fourth record from Florida. This is an apparently rare species, with only a dozen or so records from around the world, although Pryor et al (1965) found a school of more than 50 near Hawaii. No interaction is known and none is likely due in part at least to the paucity of records of this species.

Psuedorca crassidens False killer whale
Odell et al (1980) describe a recurrent mass stranding in Florida and the Dry Tortugas, and Caldwell et al (1971a) found this species amongst those caught at St Vincent. Tomilin (1967) states that it eats squid and fish and is usually found far from coasts, though it may come closer to shore following cephalopods. Odell et al (1980) found that captive specimens ate mackerel, herring, smelt and some squid, and Watson (1981) reports seeing this species eating bonito. As yet no conflict is reported with this species, but the fact that it does eat commercially important fish makes a future conflict somewhat more plausible than with previously mentioned species in this area.

Orcinus orca Killer whale
This species has been recorded from Florida (Moore 1953) and St Vincent (Caldwell et al 1971a) where it has appeared in the whale catch. Numbers are unknown, but it does not appear to be common. Food is known to include gregarious fish and marine mammals, though Caldwell et al (1971a) also report turtles as a food item. This species does not appa-

rently appear in large numbers or close to the shore as it does in Norway, and so no conflict with fisheries has been reported nor is one likely, given the catholic diet and apparently low density of this species in this area.

Globicephala macrorhynchus Short-finned pilot whale
Widely distributed throughout the region, this is the main species caught in the St Vincent fishery. Kritzler (1952) reporting on the mass stranding of 48 individuals, and subsequent captivity of 4 in Florida, states that squid is their main food. No interaction with fisheries is known at present, nor likely. The population size is unknown, but they are presumably not rare.

Lagenodelphis hosei Fraser's dolphin
The only record in area 31 appears to be that of Caldwell et al (1971a) in St Vincent. Leatherwood and Reeves (1983) state deepwater fish, crustacea, and squid are eaten. Conflicts are unknown, and unlikely.

Tursiops truncatus Bottlenose dolphin
This species is also very numerous in this area and is perhaps the most noticeable as it is chiefly a coastal species, wandering as far as the edge of the continental shelf. Moore (1953) describes it as common in Florida and it is also reported over much of the rest of the Caribbean. Payne (1979) states that 83% of its diet in the gulf of Mexico is mullet, and Shane (1980) adds a number of other demersal and neritic species. Leatherwood (1979) cites Cato and Prochaska (1976) as stating that Tursiops damages nets and catch in Florida to the tune of $0.5 million a year. They estimated the population of Tursiops in the area to be around 5000, but Leatherwood (1979) found the population to number around 500. Caldwell and Caldwell (1971) report this species both in the St Vincent fishery and as caught incidentally in beach seine nets in the southern Caribbean. Leatherwood and Reeves (1982) provide a comprehensive account of other minor interactions with fisheries. There are probably more interactions between this species and fishermen which are not recorded.

Grampus griseus Risso's dolphin
Tomilin (1967) describes this species as rare but widespread in warm and temperate waters. There are few obvious references to it in area 31 although Caldwell et al (1971b) record it at St Vincent. According to Tomilin (1967) it lives mainly or solely on squid, diving deep and long. No conflict is reported or likely.

Stenella longirostris Spinner dolphin
Recorded in area 31 by Moore (1953), Erdman et al (1973), and many others. This species is one of the main victims in the incidental dolphin take in the tropical east Pacific. It is most common in deepwater and as Caldwell and Caldwell (1971) point out, any tuna seining developed in this area may well be responsible for incidental mortality to this species. There are no abundance estimates but is is presumably fairly common.

Stenella coeruleoalba Striped dolphin
Odell and Chapman (1976) describe this species from Florida where it had fish otoliths in its stomach. Tomilin (1967) states that it is rare, but Leatherwood and Reeves (1983) describe it as widespread, and state that it feeds on small mesopelagic fish as well as shrimp squid. Like the last two species it too has been caught in the purse seine fishery for tuna in the Pacific, and hence may be susceptible if such a fishery were to develop in this area.

Stenella species Spotted dolphins
Moore (1953) lists Stenella attenuata as one of Florida's marine mammals. This is the species which has suffered most in the nets of the tuna fishery in area 77 and unlike the preceeding two species, it feeds in the surface layers on fish, as well as some squid. Payne (1979) records Stenella plagiodon as the most common Stenella species in the Gulf of Mexico. Siebenaler and Caldwell (1956) suggest that this species feeds on pinfish and squid, presumably on the surface. Like the other Stenella species, these too are vulnerable if tuna seining operations expand, using dolphin schools as markers for tuna fish.

Stenella clymene Clymene dolphin
A little known spinner dolphin, recorded on a few occasions in this area (Perrin et al 1981). Its status is unknown, but presumably its apparent rarity does not preclude it from incidental mortality in any projected tuna seine fishery.

Delphinus delphis Common dolphin
Moore (1953) and Erdman et al (1973) both describe this species from the north of area 31, and it seems to be quite common at sea there, although it may be rarer in the south. Like the Stenella species this too is caught in tuna nets being a pelagic schooling species. Tomilin (1967) describes it as a typical ichthyophagous species, feeding far from shore on smallish fish such as herring, anchovy and pipefish, as well as carangids, mullets and many others. Leatherwood and Reeves (1983) state that they feed in the deep scattering layer on fish and squids. This species too may be vulnerable to expanded pelagic fisheries in the area, although no conflicts are reported as yet.

Inia geoffrensis Boutu
Known to occur, according to Hershkovitz (1966) in the river systems of Colombia and Venezuala, this species is apparently fairly common in parts of its range although Leatherwood and Reeves (1983) believe that increasing numbers are being killed in recent years, but catch data are unavailable. The food is thought to consist of characins and catfish, two of the most plentiful groups of fish in South American fresh waters. There is some incidental catch of this species in gill net fisheries in the Amazon (see area 41) so presumably they may also be caught in the Orinoco and other rivers flowing out to area 31. However there are no data on this.

Zalophus californianus Californian sea lion
This species is reported from Georgia and South Carolina by Caldwell et al (1971), having escaped from captivity. Feral sea lions are not known to have bred, but if a breeding population became established, it might quickly become a nuisance locally.

Phoca vitulina Harbour seal
May wander as far south as Georgia and Florida, but in insignificant numbers.

Monachus tropicalis Caribbean Monk seal
Presumed extinct.

Trichechus manatus Caribbean Manatee
Shane (1983) estimates the population in Florida to total around 1 000. Elsewhere the population size is unknown. In Florida at least there is a high mortality associated with boat collisions with this species (FAO 1978). Presumably a large number of these boats are fishing boats, commercial or recreational, and in this respect manatees may be said to be interacting with fisheries. Manatees are also caught accidentally in gill nets in the rivers in northern South America, (Lavigne pers. comm.), but there appear to be no detailed data on this. As this species is entirely herbivorous, competitive interactions for food are unlikely.

Information on marine mammals in this region is extremely patchy. Extensive information exists for the more northerly parts, but, particularly off the coast of northern South America the data are more scarce. Of the 33 or so species of marine mammal found in this area, 6 species of baleen whale probably do not feed in these waters, and are anyway not common. Bryde's whale may feed on small shoaling fish, such as menhaden and possibly sardinellas. At least another ten species are thought to feed mostly or entirely on cephalopods, and do not at present interact with fisheries, and the diet of another 6 uncommon species is unclear.

Of the remaining species, the two predominantly freshwater species eat a variety of fish and crustacea, some of which are also fished for commercially. The bottlenose dolphin is known to feed on mullet and other neritic species. All of the delphinid species in this region may feed on small pelagic shoaling fish, which may include some commercial species as well as myctophids and other non-commercial species. One is herbivorous.

THE FISH STOCKS OF AREA 31

DEMERSAL FISH RESOURCES

In 1981 the total reported landings of demersal fish was 135 000 tonnes. Gulland estimates that on top of this some 500 000 tonnes of demersal fish, mostly Sciaenids, are discarded as by-catch by the shrimp and other trawl fisheries. However, in its Review of the State of Exploitation of Resources Other Than Crustaceans (1980), the Western Central Atlantic Fishery Commission (1980) put the figure for discards as high as between 800 000 and 1.5 million tonnes. They estimate another 80 000 tonnes are taken by sport fishermen, chiefly from the U.S.A. Of the reported demersal landings, no one species forms a predominant part of the catch, but groupers, snappers, croakers, grunts, drums, weakfish and slipmouths are all taken in reasonable quantities. The diversity of the fish fauna in the area makes assessments of particular species difficult if not impossible. Some stocks are probably still lightly fished, but many others, of high market value, or concentrated on the shrimp grounds are probably moderately to heavily.

SERRANIDAE

More than 20 000 tonnes of numerous species, particularly groupers (Epinephalus spp.) were landed in 1981. These are almost all from hard bottomed areas, reefs, where most fishing is done with traps, and deepwater areas on the shelf edge where they are taken principally by handline and snapper reel. Such fisheries are unlikely to involve interactions with marine mammals.

LUTJANIDAE

More than 10 000 tonnes were landed in 1981, again, from a number of species. Snappers are found in similar places to groupers, but are often smaller in size. They are taken in the same ways on reefs and on the shelf edge where they are most concentrated at around 200 metres in the Caribbean, and around 100 metres in the gulf of Mexico and Atlantic.

SCIAENIDAE

More than 30 000 tonnes were landed in 1981. These species are mostly soft bottomed species, found in the shallower waters of the shelf, particularly on the northern and eastern coasts of South America and in the gulf of Mexico. The croaker Micropogon undulatus is the species most commonly caught as a by-catch in the shrimp fisheries of the area, which are also carried out on soft bottoms. There are, however, a number of directed fisheries for sciaenids also. A small industrial fleet operates in the northern Gulf of Mexico, and other, artisanal, fisheries fish the Mexican and Central American waters. There are also some local trawl fisheries along the Caribbean coast of South America, especially the Gulf of Venezuala which is overfished already.

SPARIDAE

At present only about 2 000 tonnes of a handful of species are taken. The stocks are said to be underexploited along the shelf edge of the U.S. Atlantic coast.

Other demersal fish caught in the area include surmullets, wrasses, triggerfishes and puffers, reefs providing the highest diversities.

PELAGIC FISH RESOURCES

Pelagic catches in this area are again characterised by a great diversity of species. Only inadequate resource surveys have been made, but the potential may exceed 2 000 000 tonnes. Menhaden accounts for the main part of the total pelagic catch, together with

around 100 000 tonnes of all other species. Again, catch statistics are not reliable and actual catches may be considerably higher than this.

CLUPEIDAE

Brevoortia tyrannus and Brevoortia patronus Menhaden
The former is caught in the Atlantic off the southern United States, the latter in the Gulf of Mexico. Between them they account for a total catch of around 7-800 000 tonnes per year. The Gulf stock is thought to be at or around MSY, the Atlantic stock is overexploited, but seems to have recovered somewhat since the 1960's. These species represent much the largest single finfish fishery in the area, and are taken by purse seiners, almost all from the United States. There has been some reported by-catch of Tursiops, and a number of other species may be feeding on these stocks, but there is no evidence yet of any conflict.

Sardinella anchovia
32 000 tonnes were taken in 1981 by the purse seine fishery off Venezuela, and this species is apparently fully exploited at present.

The FAO Atlas of Living Marine Resources maintains that there are between 1 and 2 million tonnes potential yield of other clupeids in the area, but these remain largely unexploited, perhaps because of the small size of schools of many of them. These species include the thread herring, Opisthonema oglimum, for which a small fishery exists already off Brazil, as well as scaled herring, dwarf herring and anchovy. Many of these are presumably food species of delphinids and possibly of Bryde's whales too.

CARANGIDAE

Over 12 000 tonnes of a number of species are taken. According to the FAO Atlas, largest concentrations are found in the Gulf of Mexico, along the Yucatan Peninsular and off the coast of Florida, and also along the coast of Venezuala. Lowe-McConnell (1962) reports that Carangids off northern South America are most often found in clear water, away from the muddier bottomed areas near estuaries.

MUGILIDAE

Several species of mullet yielded over 28 000 tonnes in 1981. These are chiefly coastal species found in shallow waters. There is no indication of their potential, nor of the state of the stocks. Local concentrations are found in the Gulf of Mexico and on the coast of Venezuala, and in both areas they may be presumed to be important food fishes for Tursiops.

SCOMROIDEI

A great number of species, they include 9 or more tunas, spanish mackerels, marlins and other high value fish, the catch for all species in 1981 was 71 000 tonnes. Longlining and other hook and line fisheries, including the U.S. sport fishery, are important in the capture of these fish, but there is no indication as to the state of the stocks in the region. Catches by foreign vessels are small, amounting to only a few thousand tonnes per year, mostly Japanese and Korean catches of tuna. Catches of all species have remained stable since 1976, with the exception of the blackfin tuna (Thunnus atlanticus), the catches of which have increased from 90 to 845 tonnes during the last 6 years, and the white marlin (Tetrapturus albidus), the catches of which declined from 369 tonnes in 1976 to 15 tonnes in 1981. Caldwell and Caldwell (1971) have pointed out that the same species of dolphin (Stenella spp.) and of tunas exist in area 31 as in the eastern central Pacific, and that the possibility may exist for the development in area 31 of a similar fishery to that of the dolphin associated tuna fishery of the eastern central Pacific.

ELASMOBRANCHS

Elasmobranchs predominate in the fauna of the shallow inshore muddy waters of the continental shelf regions of area 31. WECAFC (1980) estimate that 54% of the biomass in water less than 55 metres deep off the United states Atlantic coast is made up of sharks and rays. Lowe-McConnell (1962) also reports them as predomiant off the coast of the Guianas in shallow waters. Current catches total around 20 000 tonnes. Mexico and Cuba are the only countries with directed fisheries, but the true catch may be a lot higher than those given in the FAO yearbook, due to sport fisheries and discards. Total potential yield has been estimated around 45 000 tonnes (WECAFC 1980), but it is unclear how closely actual catches approach this figure already.

INVERTEBRATE RESOURCES

CRUSTACEANS

The most important fishery in the region, economically, is for shrimp. At least 6 species of shrimp are taken from soft bottomed areas of the continental shelf by trawlers, chiefly from the USA, but also from Mexico, Venezuala, Surinam and Guyana. Catches exceeded 170 000 tonnes in 1981, and appear to be relatively stable over the past 6 or 7 years. This fishery is also notable for the large amount of fish discarded, anything up to 1.5 million tonnes of demersal fish per year. Some other species are also taken, including the blue crab Callinectes sapidus on the Atlantic seaboard of the U.S. and a number of lobster species from reef areas.

MOLLUSCS

Between 150 and 200 000 tonnes of molluscs are taken in the waters of area 31 every year. Most of this is in the form of bivalves, particularly the oyster Crassostrea virginica which is taken from U.S. Atlantic waters. A number of other species are taken from reefs throughout the area, largely by hand. The catch of these amounts to only a few thousand tonnes per year, but is nevertheless important to island economies.

CEPHALOPODA

The amount of cephalopods taken is very small, being less than 10 000 tonnes in any year, most of this being common squids, Sepia spp., and octopuses. There appear to be no surveys which estimate the potential size of the squid resource, but considering the location of large sperm whale feeding grounds within the area, and also the number of mammalian species in the area which appear to be largely or wholly teuthophagous, the potential may be enormous. Voss (1973) states: "there can be little doubt that vast potential stocks of octopus and squid occur in the Caribbean Sea and adjacent regions, but documentation is not available. Gulland (1971) has suggested that the potential is more than 100 000 tonnes, possibly as much as 0.5 to 1 million tonnes, and probably not as much as 2 million tonnes."

THE FISHERIES OF AREA 31

The United States is the largest fishing nation in this area, with in 1981 total recorded landings of around 1.26 million tonnes (or 66% of the total landings from the area). As has been noted its catches of menhaden dominate the statistics on fish landings. The menhaden fishery is pursued by purse seiners, and despite its size (ca. 800 000 tonnes p.a.), there appears to be little conflict with marine mammals, this being possibly due to the fact that icthyophagous mammals in the area do not appear to be very numerous, the species in the genus Stenella together with Delphinus delphis and Tursiops truncatus being perhaps the only other likely candidates for possible by-catch in this fishery.

The United States also takes large amounts of shrimp by trawlers, which again do not appear to affect marine mammals in any noticeable manner, unless the by-catch of demer-

sal fish were to affect the feeding habits of Tursiops truncatus, which is about the only mammalian species which preys on this group of organisms to any great extent. WECAFC (1980) reports that in the northern Gulf of Mexico there are already signs of groundfish over-exploitation. Similarly the fisheries for oyster and for crab do not affect marine mammals.

One of the very few records of interactions between marine mammals in this area comes from the small scale fisheries of Florida. A number of species are taken there by hooks and lines as well as by gill nets in the creeks and channels around the coast. The sport fishery is also economically very important. Leatherwood (1979) reports some conflict between these fishermen and Tursiops truncatus, one of the few mammalian species regularly found inshore in the entire region. The manatee, Trichechus manatus is also thought to be threatened in the same waters by accidental killings by fishermen, amongst others, especially from the propellors of small boats.

Mexico is the next largest fishing nation in area 31. 1981 landings were around 270 000 tonnes, or 14% of the total. Mexican catches are distributed fairly evenly amongst a great number of species. Mullets, from inshore and largely small scale fisheries are one of the more important groups landed, accounting for more than 10 000 tonnes. Groupers, snappers, slipmouths, sharks and rays are also important. Most Mexican fisheries in the Gulf of Mexico appear to be artisanal. In view of this, one might expect some conflict between fishermen and at least one species, Tursiops truncatus, which is apparently common all around the coastal areas of the Gulf of Mexico. No such conflict has yet become apparent however.

Venezuela landed 167 000 tonnes in 1981, or about 9% of the area total. Of this 27 000 was from the purse seine fishery for sardines. No conflict is apparent in this fishery. Longliners also take some tuna and related fish. Most of the rest of the catch is from artisanal fisheries along the coast, for mullets, sciaenids, groupers, grunts, sharks and other shelf fish. Caldwell and Caldwell (1971) report that the beach seine nets along the coast here, and on offshore islands do take some by-catch of marine mamals, which, as one might expect, appear chiefly to be Tursiops, although around certain river mouths Sotalia fluviatilis is also taken in gill nets.

Most of the other nations around the area have only small catches, Cuba and Guyana take about 3% and 1.5% of the total area catch respectively, and the remainder is split amongst more than 40 other nations. Although there have been developments in the fishing industries of some of these, such as Cuba, small scale fisheries still predominate throughout the area. These fisheries are pursued by a number of methods; traps are used mostly on reef areas, and hooks and lines along some of the rough-bottomed shelf areas. Beach seines and other nets are also evidently used in soft-bottomed areas. There are remarkably few reports of interactions with marine mammals, possibly due to the under-exploited nature of the area as well as the type of gear used. Gulland (1983) considers the area the least heavily fished in the world after the southwest Pacific, although some areas are over-exploited locally.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 31

Operational interactions

There are very few reports of interaction between fisheries and marine mammals in this area, and these are limited to 4 species, all freshwater or coastal, with a few more as possible future conflicts.

1 Tursiops truncatus, described by Shane (1980) as one of the 3 commonest species in the Gulf of Mexico, is evidently involved in gear conflicts throughout the area.

2 Inia would also seem likely to be caught accidentally in this area, although records of this are scarce. There are also reports of it helping fishermen in the Amazon (Lamb 1954), and it may well do the same therefore in parts of Venezuela or Colombia.

3 Sotalia is also liable to incidental capture in gill nets.

4 The Manatee is seriously overexploited and continues to suffer through accidental drownings in nets and collisions with boats throughout the region (FAO 1978).

Other instances of interaction have not been recorded. However there are at least two areas where the potential for such may exist. One is in the development of the tuna fishery, which, according to Caldwell and Caldwell (1971) could develop means of catching tuna and dolphins in the same manner as in the eastern central Pacific. They suggest this could be a useful supplement to the diet of protein-poor islanders in the Caribbean, some of whom are already accustomed to eating dolphin meat. The species involved here would be those of the genus Stenella and possibly Delphinus delphis.

A second potential interaction may be considered possible due to the reported presence of a number of feral Californian sea lions on the Atlantic coast of the U.S.A. (Caldwell et al 1971). A breeding colony of these animals could cause some nuisance to fishermen in the area, particularly to the sport fishery of the Florida and adjacent waters, as is known in Californian waters (see area 77). As yet no breeding is reported.

Biological interactions

Considering the generally underexploited state of the marine resources of the area, it would seem that any significant competition for food between fisheries and marine mammals in this area is unlikely. This is particularly so as, in common with most warmer areas of the world, there appears to be a relatively low biomass of marine mammals.

Most of the species present also appear either not to eat in the area, (the baleen whales), or else to feed primarily on squid, a greatly undeveloped resource by the fisheries of the area. Those species which are either fully or partly ichthyophagous, such as D. delphis, the Stenella species and a few others tend to be oceanic and so rarely come into contact with the primarily small scale fisheries. Only coastal species have so far been implicated in interactions.

Should any of the large squid resources become exploited to any great extent, the possibility of interactions with marine mammals should be considered far more likely than at present.

3.5 AREA 34: EASTERN CENTRAL ATLANTIC

MARINE MAMMALS FOUND IN AREA 34

Eubalaena glacialis Right whale
Tomilin (1967) describes the right whale from the north west coast of Africa, Madeira and the Azores. This represents the southern limit of the North Atlantic population which may now number no more than a few hundred. No feeding is recorded in this area.

Balaenoptera physalus Fin whale
Jonsgaard (1966a) states that this species is found as far south as 20°N off the African coast. The numbers of animals which migrate into this region are unknown, but the entire North Atlantic stocks may number no more than 12 000.

Balaenoptera musculus Blue whale
Jonsgaard (1966a) reports that the blue whale has been seen as far south as Cape Verde. There is no information on how many blue whales migrate to this region, and feeding is unlikely.

Balaenoptera acutorostrata Minke whale
Minke whales are known to be found infrequently in tropical regions. There is no information on the numbers present in this area; feeding is unlikely.

Balaenoptera borealis Sei whale
Jonsgaard (1966a) describes the southern limit of the distribution of the sei whale as

Cape Blanco off the West African coast. There is no indication of numbers in this area. The total population in the North Atlantic may be only a few thousand, but is unknown.

Balaenoptera edeni Bryde's whale
Ivashin (1980) describes the distribution of this species and states that it has been hunted off Spanish Morocco and Dakar. There are no population estimates for this or any other area. Feeding is known to occur in the tropics and includes pilchards and anchovies in other areas, as well as a large proportion of pelagic crustacea. (Best 1967).

Megaptera novaeangliae Humpback whale
Tomilin (1967) describes the migration route of the north east Atlantic stock of the humpback whale as from the Baerents Sea to northwest Africa and Cape Verde. This stock has been severely reduced and is not thought to feed in southerly areas.

Mesoplodon densirostris Blainville's beaked whale
Moore (1966) suggests that this species may inhabit a mid ocean area of the southern North Atlantic. It is only recorded rarely, and is of unknown population size, presumably no more than a few tens of thousands at most. All beaked whales feed on squid.

Ziphius cavirostris Cuvier's beaked whale
There is little information on this species in this area. The population size is unknown, but the diet is known to consist, generally, of squid.

Physeter macrocephalus Sperm whale
Sperm whales have been hunted extensively in this area in the past as the whaling maps of Townsend (1935) demonstrate. The existence of two winter hunting grounds at about 5° and 15°N indicate probable feeding grounds for sperm whales in those areas, presumably on concentrations of squid. There are little data on sperm whales in this area at present, but the Atlantic population has been estimated at a few tens of thousands 22 000, which suggests that, judging from the apparent distribution of whales on Townsend's maps, a few thousand may be in this area in the winter, and far fewer in the summer.

Kogia breviceps Pygmy sperm whale
Very little information exists for this species in this area, as there are few records of it in Africa (Handley 1966). Cadanet (1959) reports two unconfirmed records. There is no information on population size. Food is thought, in other areas at least, to include squids, crabs and shrimps.

Steno bredanensis Rough-toothed dolphin
No population estimates are available and there are very little data on feeding. Hershkovitz (1966) states that it occurs as far south as Senegal and the Ivory Coast, where Cadenet (1959) examined the stomachs of 3 individuals and found cephalopods in all 3 and some indeterminable fish in 2 of them.

Sousa teuszii Atlantic hump-backed dolphin
Hershkovitz (1966) describes the distribution of this species as along the West African coast from Senegal to the Cameroons, in the mouths of rivers and in shallow waters. Cadanet (1956, 1957, 1959) records a number of individuals from the coasts of Senegal and the Ivory Coast. At least 7 of these were caught in shark nets and one in a sardinella net. The stomachs of four animals which Cadanet (1959) examined contained Ethmalosa dorsalis, three of them also containing Mugil remains. Cadanet (1959) suggests that although once thought rare, this may be a common species locally. Busnel (1973) describes how fishermen in Mauritania co-operate with dolphins of this species. The fishermen beat the surface of the sea when, during the period December to February, there are schools of mullet running along the coast. The dolphins are then said to corral the fish in to the shore while fishermen on the one side and dolphins on the other catch them. This is one of the few examples of interaction between man and marine mammals where both parties benefit.

Peponocephala electra Melon-headed whale
There appears to be only one record of this species in this area, that of Goodwin (1945). There is therefore no information on population size nor on feeding.

Feresa attenuata Pygmy killer whale
Caldwell and Caldwell (1971a) summarize the information on the distribution of this species at that time, with only one record from the tropical east Atlantic although Cadanet (1959) reports two possible records from Senegal and the Ivory Coast. There is therefore no information on population size nor on feeding in this area. Captive specimens have eaten fish and squid in Japan.

(Pseudorca crassidens False killer whale
There are no obvious records of this species in this area, but Tomilin (1967) amongst others describes its disribution from the North Sea to the Cape in South Africa. Tomilin describes the diet as predominantly squid, but also including some fish.)

Orcinus orca Killer whale
A cosmopolitan species which is more common in higher latitudes, there is very little information on this species in area 34. Bourne (1965 cited in Mitchell 1975) states that the killer whale is shot on sight on the Atlantic seaboard of Morocco where it is believed to scare tuna fish (Thynnus thynnus) away from the fishing grounds, Cadanet (1959) also records its presence further south. The population size and diet are unknown in this area.

Globicephala macrorhynchus Short-finned pilot whale
Mitchell (1975a) affirms the presence of this species as far north as Mauritania and Madeira, and Cadanet (1959) examined 2 specimens further south, one with fish and squid remains in its stomach, the other with only squid remains. There is very little or no other information on the diet or the abundance of this species.

Tursiops truncatus Bottlenose dolphin
Busnel (1973) records this species in Mauritania and Cadanet (1957, 1959) records it on the West African coast too. In his description of cooperation between fishermen and dolphins Busnel states that two species were involved, one of which was not able to be identified, but which was "probably Tursiops truncatus". The diet of the bottlenose dolphin is elsewhere known to include mullet (Mugil spp.) and so it would seem safe to conclude that as mullet are abundant in this region they are likely to form part of the diet of Tursiops here also. Cadanet (1957) refers to a troupe of bottlenose dolphins attacking a trawl net, which had to be frightened off with explosive charges. Another is recorded in an unspecified net. There is no indication of abundance in area 34.

Grampus griseus Risso's dolphin
Widely stated to exist in warm waters worldwide, as with other species in this area there is little or no information pertaining to this species in this area. Risso's dolphin is known to prefer deeper water and to feed on squid, and is generally uncommon.

Stenella longirostris Spinner dolphin
Cadanet (1959) records this species from Senegal and the Ivory Coast. There are reports of dolphins being caught in tuna seines off the coast of West Africa. Maigret for example is quoted in the report of the Sub-Committee on Small Cetaceans (IWC 1982) as stating that 7 French seiner captains made on average 12 sets on dolphins annually, killing about 14 per set. By extrapolation Maigret suggests that 3 300 dolphins are killed in this manner each year. There is no indication of the species involved, but by analogy with other areas they may be presumed to be largely Stenella species. The spinner dolphin is thought to eat mesopelagic fish and mesopelagic and epipelagic squids, though there is no data for this area. There are no population estimates for this area either, although by analogy with the eastern tropical Pacific, a population of more than a million would not seem unreasonable.

Stenella coeruleoalba Striped dolphin
Little information is available on this species, and although it may be involved in the tuna seine fishery as described for S. longirostris, in other areas the main species involved in tuna seining operations are spinner and spotted species.

Stenella spp. Spotted dolphins
The taxonomy of these species is still confused. At least 4 species have current acceptance in the Atlantic. The comments concerning the incidental capture of dolphins in

tuna nets under Stenella longirostris almost certainly apply to spotted dolphins also, as it is they which are chiefly involved in the eastern tropical Pacific tuna fishery. By analogy with the eastern tropical Pacific a population of the order of a million would not seem unreasonable in this area. Mitchell (1975) states that as spotted dolphins are involved in the eastern tropical Atlantic tuna fishery, a high priority should be given to the solution of taxonomic problems in that area.

Stenella clymene Clymene dolphin
There is very little information on this species which is not common, and has only recently been accepted as a species. Cadanet (1959) refers to it in this area though.

Delphinus delphis Common dolphin
This is one of the species which Cadanet (1957, 1959) records for the West African coast. There is no indication of population size, but the Report of the Small Cetacean Sub-Committee (IWC 1982 pp 113-126) states that common dolphins are killed in surface trawling for sardines and mackerel in this region. One trawler was said to have caught 6-22 dolphins per haul at night, in an area where 12 trawlers were fishing. Cadanet (1957) refers to this species being taken in beach seines on the West African coast where he states that it is common. Cadanet (1959) found sardinellas, anchovies, mullet and strongylura in stomachs which were examined.

Phocoena phocoena Harbour porpoise
Another of the species found by Cadenet (1959) in this region; Gaskin (1983) summarizes other reports of its presence in the area. There is little recent information however and none on the size of population. Cadanet (1959) mentions that one was found to have 3 Mugil in its stomach, and Cadanet (1957) refers to 3 caught in beach seines in this area.

Monachus monachus Mediterranean monk seal
This species still survives in discrete and very small populations on the Mauritanian coast and the Desertas Islands. Food from the stomachs of specimens in this region indicate a diet including horse mackerel, sparids and rays. The two populations are thought to total around 100 animals (Sergeant et al 1978).

Trichechus senegalensis West African manatee
Husar (1978) provides a comprehensive review of this species, giving its distribution as from Senegal to Angola, in river estuaries and coastal regions. The manatee is said to prefer shallow weedy estuaries, and feeds on vascular plant material. There are no population estimates, but although the species is protected throughout most of its range, hunting still continues illegally. Husar states that the population is severely reduced at present and attributes this not just to hunting, but also to incidental captures of this species in shark netting. Sikes (1974) also states that new monofilament meshes have contributed to the decline of this species in Nigeria.

There is overall an extreme paucity of information on marine mammals in area 34. Very little is known on the distribution of marine mammals within this area, and even less on their diets. At least 26 species are thought to inhabit these waters for at least part of the year. 7 of these are baleen whales, which presumably do not feed to any great extent at these latitudes, and anyway are mostly confined to the northern part of area 34 for a limited part of the year. The exception is the Bryde's whale, the distribution of which is more tropical than other species; this may consume some unknown quantity of small pelagic shoaling fish.

Of the remaining 19 species, at least 6 are known to feed predominantly on squid. Of these, only the sperm whale has been known to inhabit this area in large numbers. Another 4 species have been recorded so infrequently worldwide that their diets remain obscure; these are the rough-toothed dolphin, melon-headed whale, pygmy killer whale, and the short-finned pilot whale. Of the remaining 8 cetacean species 4 may have their diets guessed at in this region. The killer whale is known to frighten tuna fish off Morocco and may therefore prey on this species in part. The Atlantic hump-backed dolphin and the bottlenose dolphin may both be presumed to consume mullet as a part of their diet. It is also possible, but by no means sure, that as common dolphins are caught in surface trawl nets for sardines and mackerel they may consume these species of fish.

The last 4 cetacean species are a nominal 3 Stenella species and the harbour porpoise. The diets of the former are known to consist in other areas of small shoaling fish and squids including myctophids. The latter species consumes a variety of species including commercial ones such as gadoids and clupeids; its diet in this area however cannot be surmised.

THE FISH STOCKS OF AREA 34

DEMERSAL FISH RESOURCES

The northern part of this region, in the upwelling zone, is among the richer fishing grounds of the world, though the demersal stocks are somewhat less productive than the pelagic ones (Belveza and Bravo de Laguna 1980). The southern, tropical part is less productive, (Troadec and Garcia 1979). Total demersal catches in 1981 were a little under half a million tonnes, with most stocks, according to CECAF studies, being fully exploited. Over the years there have been large changes in the species composition.

There are no specific records of any of these being consumed by marine mammals in this area, but one might expect at least 3 marine mammal species, the hump-backed dolphin, the bottlenose dolphin, and the harbour porpoise to be capable of some interaction with fisheries for these species, as they are all found in coastal waters, and may feed on demersal fish.

BALISTIDAE

Balistes spp. Triggerfish
Catches in 1981 rose to 102 000 tonnes from 10 000 tonnes in 1978. Gulland (1983) says of this group of fish that "tough skin and strong spine render a commercial use difficult - even for fish meal Balistes is unattractive." There are no records of interactions between these species and marine mammals in this area.

GADIDAE

Merluccius spp.
There are several stocks of these species, which include M. merluccius and M. senegalensis. Total catches in 1981 exceeded 38 000 tonnes, these stocks are particularly important in the north of the area, and seem to be fully exploited at present. No interactions are known with marine mammals.

Other demersal species include a few flatfish species (about 30 000 tonnes taken in 1981) and sea breams, which are more important in the north of the area. Further South the main groups are croakers, grunts and threadfins, particularly on muddy bottoms, and also sea breams, grunts, snappers and groupers and goatfish on harder bottoms. In the tropical zone offshore, that is in waters of depth more than 70 metres, sea breams, cusk eels and black croakers are important (FAO 1981). Porgies have been reported in the stomach of one monk seal, but this seems unlikely to represent a significant interaction between the monk seal and local fisheries.

PELAGIC FISH RESOURCES

The pelagic catches in 1981 were around 2 million tonnes. Most of the major stocks are heavily exploited but some others particularly in the south could produce higher yields with harder fishing. Gulland (1983) states that Balistes species are becoming dominant in the pelagic community in some places. This region seems to have a number of species such as horse mackerels, mackerels, and sardinellas, which occur near the bottom, over the shelf edge, and are taken by trawlers, mostly from foreign nations.

CLUPEIDAE

This family is represented in the catch statistics most prominently by a number of Sardinella species and the pilchard, Sardina pilchardus. The pilchard (sardine) stocks are probably currently under exploited with catches of around 500 000 tonnes and estimated potentials of 800 000 tonnes (FAO 1981a). The sardinella stock off Ghana and the Ivory coast, however, has collapsed (Gulland 1983), whereas elsewhere higher catches could still be achieved (FAO 1981a). The known involvement of marine mammals with these stocks is limited to the example quoted above, in which common dolphins (D. delphis) are caught in surface trawl nets, possibly in fairly large numbers. Nevertheless it is possible that other interactions have so far gone unnoticed. It would seem reasonable that common dolphins may be consuming pilchards here as they do in the Mediterranean; the effects of a significant catch of dolphins and a possible future increase in fishing effort on pilchards in this area can only be surmised.

It should also be noted that there are an unknown number of Brydes whales in this region which may be assumed to feed locally. This species of baleen whale has been known to consume pilchards in other areas, and therefore such an interaction cannot be ruled out in this area.

ENGRAULIDAE

About 90 000 tonnes of various anchovy species were taken in this region in 1981, and comments concerning D. delphis and B. edeni and their predation on pilchards may apply in part to anchovy stocks also.

MUGILIDAE

Mugil spp.
Two species, M. cephalus and M. auratus are reported by Busnel (1973) in his account of the interactions between Sousa and the fishermen of Mauritania. Mullet are largely a coastal species and so presumably are taken along the coast of this area by artisanal fisheries, as most of the purse seiners, trawlers and other large fishing vessels work further offshore. Catches are around 20 000 tonnes per annum, and it may be assumed that both Sousa and Tursiops prey on these species.

SCOMBRIDAE

Scomber japonicus
This species is taken largely in trawl nets and is currently probably over-exploited (Gulland 1983). As has been noted already, common dolphins are known to be taken as a by-catch, and may well feed on this species too. The extent of this interaction remains unclear at present, but possibly a large number of dolphins are killed in this fishery.

Tuna species
A number of tuna species are taken in this area, and two interactions with marine mammals have already been noted. An estimated 3 300 dolphins of unknown species, but possibly of the genus Stenella, may be caught in tuna seining operations every year in this area in (IWC 1982). There is also the record of Bourne (1965 cited in Mitchell 1975) of killer whales being shot at by tuna fishermen in Morocco, but no more recent information is available on this particular conflict.

OTHER SPECIES

Horse mackerel (Trachurus spp.) stocks in this region could possibly produce higher yields if fished harder, but they are fairly fully exploited already (Gulland 1983) with a catch in 1981 of 360 000 tonnes. There are no reported conflicts with marine mammals. Other important pelagic stocks include a number of Caranx species.

INVERTEBRATE RESOURCES

CEPHALOPODA

Voss (1973) describes the northwest coast of Africa as having one of the richest cephalopod fisheries in the world. Gulland (1983) suggests that the cephalopod stocks in this area may now be overexploited. The main species caught include Sepia officianalis, Loligo vulgaris, and Octopus vulgaris.

THE FISHERIES OF AREA 34

Gulland (1983) summarizes the fisheries of this area. After a period when the fisheries were dominated by foreign vessels, local boats have started to take a larger share of the catch since the late 1970's. In the north of the area there are large local fleets purse seining for sardines, and to a lesser extent, trawling for hake and a variety of other demersal species. The Mauritanian coast includes large areas of desert land with a very low human population density, and almost no local fishing. Further south, Senegal has a large traditional fleet employing small seines and gill nets for pelagic species, as well as a smaller fleet of modern trawlers and purse seiners, which take shrimp and other demersal species, and tuna and sardinella.

Further south still, most of the West African countries have well developed artisanal fisheries, commonly using gill nets, hand lines and various types of seines. A number of these countries, including the Ivory Coast, Ghana, Nigeria and Togo, have modern industrial fleets of trawlers and some seiners.

A number of foreign fleets still operate in the waters of area 34, particularly off the West Saharan coast. Purse seiners and trawlers are both employed to catch a wide variety of fish such as tuna, sardinella, mackerel, horse mackerel, hake, sea bream and shrimp.

Throughout the region, artisanal fisheries are important, and although by-catch statistics are not recorded, it would seem probable that a number of species, such as Tursiops, Sousa, Trichechus, and possibly Delphinus and Phocoena are taken in appreciable numbers, particularly in gill nets.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 34

The recorded information on this subject is very sparse, with only a few recorded interactions. Operational interactions are almost certainly far more widespread than the available information suggests.

Operational interactions

1 By-catches have been recorded in 3 situations. Common dolphins are known to be taken by midwater trawl, possibly in quite large numbers, and in beach seines; Phocoena, Tursiops and Sousa have all also been recorded in gill and seine nets: Manatees are known to become caught in gill nets throughout their range, and some unspecified species, presumably Stenella, are taken in tuna purse seining operations, again possibly in large numbers.

2 Atlantic hump-backed dolphins and probably bottlenose dolphins are known to cooperate with fishermen in herding shoals of mullet off the Mauritanian coast.

3 Killer whales are reportedly shot on sight off Morocco where they are said to scare tuna schools away from the fishing areas. Tursiops is also reported to harass trawlers.

Biological interactions

No biological interactions are reported, but a number of marine mammal species are presumed to eat commercial fish species.

Bryde's whales and common dolphins may be presumed to feed on some shoaling commercial species such as sardinella, pilchard, anchovy and possibly mackerel and horse mackerel also. Of these only the sardinella is thought to be over-exploited by commercial fisheries, but the implications of this type of interaction are unclear.

Other possible biological interactions involve the 6 species of marine mammal which are known to feed on squid. The cephalopod resources of the area are heavily fished and possibly overexploited. The extent to which the commercial fishery overlaps with the marine mammals in terms of prey species is not known, and again, the implications of the interaction are unclear.

3.6 AREA 37: MEDITERRANEAN AND BLACK SEA

MARINE MAMMALS FOUND IN AREA 37

Eubalaena glacialis Right whale
Tomilin (1967) states that this whale is found in the Mediterranean, but such occurrences are presumably very rare as only a few hundred individuals are thought to survive from the North Atlantic population (Berzin and Vladimirov 1981).

Balaenoptera physalus Fin whale
Tomilin (1967) states that this species is also found in the Mediterranean where a few individuals migrate in the winter, there are no estimates of the numbers involved, but Viale (1981) indicates that this number should be in the hundreds at least. This species has also been reported in incidental captures in the western end of the Mediterranean (Duguy et al 1983).

Balaenoptera acutorostrata Minke whale
Hershkovitz (1966) states that this species is present in the Mediterranean and the Black Sea, and Di Natale (1983a) records the incidental capture of 4 individuals in surface drift nets between 1978 and 1982. No estimates are available for the population size, nor are any feeding data available for this area.

Mesoplodon bidens Sowerby's beaked whale
This species is recorded as being present in the Mediterranean (Hershkovitz 1966), but is apparently rare in this area.

Ziphius cavirostris Cuvier's beaked whale
A relatively uncommon species, Duguy et al (1983) record the capture of a total of 14 individuals between 1972 and 1982, 11 in French and 3 in Spanish waters, 14 of them were shot and 1 harpooned. Preferring deeper waters this species feeds on squid; the population size in the Mediterranean is unknown.

Hyperoodon ampullatus Northern bottlenose whale
Not recorded in fishing nets or strandings in recent years, Tomilin (1967) records it as present in the Mediterranean; preferring water deeper than 1 000 metres, this species feeds mostly on squid.

Physeter macrocephalus Sperm whale
Di Natale and Mangano (1983) give details of records of 448 individuals in the central Mediterranean between 1978 and 1982. Of these 20 specimens were captured in drift nets, 3 in trawls, 1 in gill netting, and one by a drifting longline. They suggest that human activity may therefore play an important part in the mortality of sperm whales in the seas around Italy. Viale (1981) suggests that sperm whales are now much rarer in the western Mediterranean than they have been in the past, but no population estimates are available.

Steno bredanensis Rough-toothed dolphin
Another apparently rare species, not recorded in nets or as having stranded recently, although Mitchell (1975) states that it seems to occur "in small numbers". Preferring deeper water there is little data on feeding.

Pseudorca crassidens False killer whale
Not recorded in any nets recently, this species is apparently uncommon in this area. It prefers deeper water, but in other areas at least is found inshore also, feeding on squid and fish, including commercial species (Carangids).

Orcinus orca Killer whale
Another uncommon species, Duguy et al (1983) report just one capture known to them, in Italy, in the period 1978-1982. There is no information on population size, which is presumed to be small. Feeding is on a wide range of food items and elsewhere is known to include a wide range of commercial species.

Globicephala melaena Long-finned pilot whale
A number of individuals are known to become caught in fishing and other gear. Duguy et al (1983) report 26 individuals in the western Mediterranean between 1978 and 1982, at least 3 of which were caught in tuna nets. The population size is unknown, as is the diet in this area, although presumably the latter consists mostly of squid.

Lagenorhynchus acutus Atlantic white-sided dolphin
Apparently uncommon, with no recent records of incidental capture, Marcuzzi and Pilleri (1971) state that this dolphin has been seen in the Adriatic, but Leatherwood and Reeves (1983) suggest it does not occur further South than the British Isles. Diet and population size in this area are unknown.

Tursiops truncatus Bottlenose dolphin
One of the more frequently caught species in fishing nets, there has also been a live capture fishery in the Adriatic (Mitchell 1975) and a directed fishery in the Black Sea which was stopped in 1983. The Black Sea population may have been dramatically affected by the fishery (Smith 1976); there are no estimates of the current population size, but catches in recent years were probably in the tens of thousands, as since 1967 between 56 000 and 222 000 animals of 3 species were being taken per annum (IWC 1983: Rep of the Sub-Committee on Small Cetaceans). In the western Mediterranean Duguy and Hussenot (1982) record 3 individuals caught in trawl nets, and Duguy et al (1983) report a number of other incidental captures. This species is one of the commonest in this area, but no population estimates are available. The food in the Black Sea is said to consist of mullet and herring, and a number of other commercial fish species (Tomilin 1967). Tomilin also quotes Police stating that this species used to cause damage to the sturgeon fishery in the Danube, in pursuit of food species, and that it also caused damage to nets and catch in the Mediterranean, particularly of the species Smarus vulgaris and S. alcedo.

Grampus griseus Risso's dolphin
An uncommon species throughout its range, nevertheless Duguy et al (1983) report 11 incidental captures in 4 years in the western Mediterranean, in a number of different types of net. This species feeds mostly on cephalopods.

Stenella coeruleoalba Striped dolphin
One of the more commonly caught species in nets in this area, Duguy et al (1983) report a total of 23 individuals in a variety of nets. Collet (1983) suggests that around 100-200 small cetaceans, mainly this species and the common dolphin are taken every year in French Mediterranean waters, both directly (for food and to scare them away from tuna trolling lines) and indirectly in nets. Di Natale (1983) describes this species as one of the most common in the central Mediterranean, preferring offshore waters. He also states that this species is caught in tuna seine nets in the Ligurian Sea, but not necessarily with any great loss of life. The food is said to consist mainly of sardines and anchovies (Di Natale 1983).

Delphinus delphis Common dolphin
This is another frequently caught species (see comments for preceding species), and is also one of the three species which was caught in the Black Sea until recently. There are no recent population estimates, except Viale's (1981) suggestion that around 8000 are present in the northwest Mediterranean, presumably the population in the Black Sea at least is depleted. Duguy et al (1983) report a total of 8 individuals as incidental captures in a variety of nets. This species is known to annoy Greek fishermen (IWC Small Cetacean sub-committee 1977). Tomilin (1967) relates that it is also known to help

Mediterranean sardine fishermen, who follow the dolphins which are responsible for frightening the fish to the surface. He continues that the population of 500 000 animals in the Black Sea destroys 2 500 tonnes of fish per day, and that on the coast of Anatolia where "the population of dolphins totals about one million" they consume 1 million tonnes of fish in 100 days. The food of this species in this area is known to include chiefly sprats and anchovies and also pelagic pipefish, as well as a variety of other species including horse mackerel and mullet (Tomilin 1967).

Phocoena phocoena Harbour porpoise
The third of the three species caught in the Black Sea fishery, it is nevertheless thought to be absent from the western Mediteranean (Gaskin 1983). In the Black Sea they are known to eat anchovy, silverside and especially gobies, and a number of other species in smaller quantities. There is no recent information on incidental captures of this species in area 37, nor on its status outside the Black Sea where it is presumably severely depleted after heavy exploitation for decades (see T. truncatus).

Monachus monachus Monk seal
The only pinniped found in this area, the numbers of this species are severely reduced, and may now number only about 500 (Ronald and Healey 1976). Sergeant et al (1978) indicate that the population is threatened by human activity including that of fishermen who, in some areas, are known to club seals and to shoot them, as they damage nets. They also state that incidental captures are known from tuna nets, in trammel gill nets, on baited hooks and possibly in trawls. The food is known to include a large number of species including Mullus surmuletus, Mugil cephalus, Boops boops, Dentex sp., and octopus.

Of the 18 species of marine mammal thought to inhabit the Mediterranean, 6 are known to feed either exclusively or partly on squid. The diet of the 3 species of baleen whales which are found in these waters remains uncertain, and they may not feed at all as baleen whales in general do not feed in the winter in the south of their range. It is possible that minke or fin whales do consume some fish, such as sardines or sprats, but this must be of minor importance.

Of the remaining 9 species, 4 feed on unknown species, of which the killer whale, the false killer whale, and the Atlantic white sided dolphin are all known to feed on commercial species elsewhere in the world. 5 species are known to consume commercial fish species in this area.

The 5 species of marine mammal are the harbour porpoise, the bottlenose dolphin, the common dolphin, the striped dolphin, and the monk seal. The food items include mullets, red mullets, herring, anchovies, sprats, pipefish, silverside, gobies, sardines, horse mackerel, bogue, dentex and octopus.

THE FISH STOCKS OF AREA 37

DEMERSAL FISH RESOURCES

The total demersal catch is around 500 000 tonnes (FAO 1981a). The Review of the State of World Fish Resources (FAO 1981a), on the basis of studies by the General Fisheries Council for the Mediterranean suggests that stocks on the northern and western shores of the Mediterranean are over-exploited, whilst those on the African and Asian shores are 'moderately to fully exploited'. Few demersal species are involved with interactions with marine mammals, and Tursiops and Monachus are probably the only species which feed to any great extent on demersal fish in this area.

SPARIDAE

Boops boops Bogue
Bogue is a one of the main catches of the area particularly in the Aegean and in the western end of the Mediterranean. This species is one of the known food items of the monk seal. The state of the stocks of bogue are unknown, but the low numbers of monk seals are unlikely to seriously alter their condition. Over 25 000 tonnes were reported caught in

1981, and the catch has been stable for a number of years.

MULLIDAE

Mullus spp. Red mullets
These species accounted for more than 25 000 tonnes in 1981, and catches have fluctuated between 20 000 tonnes and 25 000 tonnes since 1976. The state of the stocks is unknown, but presumably stable. The demersal stocks of the western Mediterranean are in general heavily fished and suffer from growth overfishing, but catches remain stable (GFCM, 1978). Red mullets are known to be eaten by D. delphis and M. monachus, but is unlikely to form the major part of the diet of either of these species.

Other species
In terms of weight of catch the only other demersal species which figure prominently in the catch statistics are Micromesistius poutassou, the blue whiting, which has sustained a yield of between 9 and 19 thousand tonnes between 1976 and 1981, Merluccius merluccius, the European hake (28 000 tonnes in 1981) and picarels (Maena spp., 13 000 tonnes). None of these species are reported as food items of marine mammals in this area.

PELAGIC FISH RESOURCES

The pelagic catch in 1981 totalled over 1 110 000 tonnes. FAO's Review of the State of World Fishery Resources (FAO 1981a) states that some stocks are already over exploited, whilst others (e.g. anchovy) could be more heavily fished. The pelagic fish of the area seem to be more important to marine mammals then demersal ones. The common dolphin is described by Tomilin (1967) as mainly feeding on pelagic fish far from shore, and Stenella coeruleoalba has been similarly described by Di Natale (1983).

CLUPEIDAE

Engraulis encrasicolus European anchovy
This species supports the single largest fishery of any species in the area by a large margin. Nearly 600 000 tonnes were taken in 1981, most of which was taken from the Black Sea. Turkish catches of anchovy have increased from 80 000 tonnes in 1976 to 273 000 tonnes in 1981. FAO's (1981a) Review of the State of World Fishery Resources indicates that concern has been expressed over the state of this stock.

All 4 species of small cetacean whose feeding habits have been studied are known to eat this species. Tomilin (1967) states that it may form 99% of the diet of D. delphis in some parts of the Black Sea in spring. Although not a major part of the diet of Tursiops, it has also been recorded (Tomilin 1967), whilst the other species in the Black Sea, P. phocoena is also known to feed on the anchovy heavily. In the central Mediterranean, anchovy is also the main food of the pelagic dolphin Stenella coeruleoalba. It can be seen that anchovy is an important food source for at least 3 species of small cetacean. In past years common dolphins have been accredited with consuming vast quantities of anchovies in the eastern end of this area (see above), but the presumed reduction in the numbers of dolphins in the Black Sea must have also reduced the amount of anchovy and other fish eaten. The current high level of exploitation of anchovy stocks coupled with the fact that the severely reduced populations of both P. phocoena and D. delphis in the Black Sea have recently been relieved of exploitation, must present the possibility of future conflict if the dolphins are to increase in numbers. Conflict could also arise in the Mediterranean where the anchovy stocks are also heavily exploited, though small cetacean populations may not be so severely reduced as in the Black Sea.

Sardina pilchardus Pilchard/Sardine
There is some suggestion that stocks of this species are over-exploited off France and Morocco (FAO 1981a), with catches in 1981 reaching 233 000 tonnes. Known to be eaten by the pelagic species Stenella coeruleoalba, and also, according to Tomilin (1967) by D. delphis. The fact that this species is concentrated in the western end of the Mediterranean, where the harbour porpoise P. phocoena is apparently absent suggests that for

these 2 species at least there is not likely to be any considerable interaction.

Sprattus sprattus Sprat
Sprats yielded 100 000 tonnes in 1981 in this area, their area of greatest concentration being the Black Sea. The common dolphin is known to feed on them and many of the comments on anchovy may therefore apply to this species also.

MUGILIDAE

Mugil cephalus Striped mullet
This species is thought to be the main food of the bottlenose dolphin in the Black Sea at least (Tomilin 1967), and is presumably important elsewhere also. The total catches in area 37 in 1981 were only 3 000 tonnes, so it may not be considered to be an important commercial species. Catches of other Mugil species however totalled nearly 15 000 tonnes; the importance of other species in the diet of marine mammals is not known. Monachus monachus is also known to eat the striped mullet.

CARANGIDAE

Trachurus spp. Horse mackerels
The horse mackerel is known to be eaten to some extent by the common dolphin. Catches in 1981 totalled 90 000 tonnes (all species), but it has been suggested (FAO 1981a) that the fishery could be expanded in a number of places. It is not possible to predict the effects of such an expansion on any interaction with marine mammals.

SCOMBRIDAE

Tuna species
Although by no means important as food species for marine mammals, these species are important commercially, and their capture is known to affect some species of marine mammal (see below).

INVERTEBRATE RESOURCES

CEPHALOPODA

Squids and octopuses are relatively important in this area, with total catches for all species in 1981 exceeding 50 000 tonnes. The fisheries are pursued with a number of gear types including trawls, trolled jigs and lights, dipnets, trammel setnets, and other types of nets and traps (Voss 1973). Voss doubts that the potential in this region exceeds 100 000 tonnes, but there is a considerable biomass of cetaceans (at least 7 species) in this area which feed either entirely or partly on squid.

Whereas a number of commercial species of fish and cephalopod are known to be important in the diet of some marine mammals, it should be noted that a number of other species are also important in marine mammal diets which are not commercially important. The harbour porpoise is said to feed mostly on gobies in the Black Sea, whilst pelagic pipefish are important in the diet of the common dolphin. It should also be noted that for at least 5 species of marine mammal present in area 37 there are no data on feeding. None of these species is thought to be present in very large numbers, but some of them are known to consume commercial species elsewhere.

THE FISHERIES OF AREA 37

Trawling with boats ranging up to 200-300 tons is very important in the region, for both demersal and pelagic species. Purse seines and similar surrounding nets (ring nets, lamparas) are also important for small pelagic species (sardines, mackerels etc.) and for tunas.

A number of traditional and artisanal fishing methods are retained in this region. Large traps are used to catch tuna in a number of places in the Mediterranean. Beach seines, particularly in the eastern end of the Mediterranean are used to catch mullet, bogues and other inshore fish. Gill nets and trammel nets are used for the capture of fish in shallow waters also, such as species of Sparidae and Serranidae, whilst drift nets are used for sardines and other pelagic fish, including some scombrids. A number of other artisanal gears are also employed.

The incidental capture of marine mammals has been recorded in a great number of gear types. The capture of minke whales in drift nets should be noted: whilst Di Natale (1983a) does not record the species of fish being sought here, it is interesting to speculate that minke whales thus caught may be feeding on that same species, possibly sardines or anchovies. Sperm whales have also been caught in drift nets and trawls, gill nets and even on a drifting longline. Pilot whales have been caught in tuna nets (type unspecified) and tuna seine nets have also caught a number of Stenella coeruleoalba.

The incidence of shooting of marine mammals should be noted. The total value of the Mediterranean catch is one of the highest among the regions of the world, despite the relatively low volume (FAO 1981a). This is because of the high market values fish may attract in Europe and the Mediterranean. The large number of artisanal fisheries and the predominance of small boats indicates that a large number of fishermen are employed throughout the area. These two facts may help explain the large numbers of cetaceans, and the numbers of monk seals, which are shot or otherwise killed by fishermen who doubtless regard them as unfavourable competitors for a relatively scarce and expensive resource. Duguy and Hussenot (1982) claim that several thousand dolphins, mostly Stenella coeruleoalba and Delphinus delphis are killed every year in this way by French fishermen.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 37

In a relatively small intensively fished area where fish fetches a relatively high price, it would perhaps be surprising if marine mammal fishery interactions were not a prominent feature. Despite this the available information on the subject is comparitively sparse. Tomilin's (1967) account of marine mammals in the USSR contains much information on the feeding habits of a number of species in this area and also details a number of (now) dated examples of interactions with fishermen.

Operational interactions

As regards incidental captures, with so many small scale fisheries operating in the area it would be surprising if these were not widespread, and yet only a few papers by Duguy, Di Natale and others provide any information on the subject. It would appear nevertheless that many of the species occurring in this area are also subject to incidental capture.

1 Bottlenose, striped and common dolphins are the 3 species most frequently caught incidental to fishing operations, using a variety of gear.

2 Fin whales, minke whales, Cuvier's beaked whales, sperm whales, pilot whales and Risso's dolphin are also caught or killed in a variety of fishing operations in small numbers.

3 Monk seals are known to damage nets and annoy fishermen.

Biological interactions

Competitive interactions are even less clear, but it would seem that a number of marine mammal species are currently depleted, notably the common dolphin, harbour porpoise and bottlenose dolphin in the Black Sea. The recovery of these stocks must bring into question the possible future conflict with anchovy and other fisheries in the area.

3.7 AREA 41: SOUTHWEST ATLANTIC

MARINE MAMMALS FOUND IN AREA 41

Eubalaena glacialis Right whale
Mermoz (1980) reports on the status of this species in area 41. At least 120 individuals are thought to migrate to the coastal waters of Argentina, Uruguay and possibly Brazil, to places where they have not been seen for a number of years. No fish are eaten and no conflicts would seem likely, although there is one record of an individual being killed by fishermen in Brazil in 1972 (IWC 1977). The world's first marine nature reserve was set up off the Chubut Peninsula in Argentina in order to protect a valuable breeding site of this species in that region (Goodall and Cameron 1980).

Caperea marginata Pygmy right whale
Recorded from the Falklands/Malvinas (Ross et al 1975), this species is uncommon, and apparently does not feed on fish. No interactions with fisheries are recorded or likely.

Balaenoptera physalus Fin whale
An unknown number of fin whales, presumably in the low tens of thousands, winters in the waters of area 41. Feeding is unlikely, and no other interactions with fisheries have been recorded.

Balaenoptera musculus Blue whale
Unknown numbers migrate into this area during the winter, possibly thousands rather than hundreds, but the fact that they are thought to fast in the winter (MacKintosh 1965) and the low population levels make interactions with fisheries unlikely.

Balaenoptera acutorostrata Minke whale
There is a breeding population off the coast of Brazil which is subjected to some whaling, although this is due to be phased out by 1985. Williamson (1975) describes the fishery, which occurs off the north east tip of Brazil ($7^{o}S$). Minke whales congregate over the continental slope 50 km offshore; around 1 000 were taken per year. The stomachs were almost always empty. The size of the breeding population in this area is unknown, but presumably in the tens of thousands at least. No interactions between this stock and fisheries is envisaged.

Balaenoptera borealis Sei whale
An unknown number of sei whales spend the winter in area 41, possibly tens of thousands; there is known to be some mixing between the west and east South Atlantic stocks (Antarctic areas II and III) (Gambell 1977). Williamson (1975) records the capture of a few sei whales in the Brazilian minke whale fishery in the 1950's. There are no interactions with fisheries, and these do not seem likely as most feeding is on krill in the Antarctic (Nemoto 1959).

Balaenoptera edeni Bryde's whale
Gambell (1977) suggests that there may be an inshore and an offshore stock of this species off Brazil. Bryde's whales tends to stay in warmer waters, but very little is known of this species in this area. The diet is known to include fish in other areas, so some commercial fish may be eaten here, however, no conflict is evident at present. The population size is unknown, but could be in the thousands.

Megaptera novaeangliae Humpback whale
A breeding ground occurs off north eastern Brazil (Mackintosh 1965); the total population in area 41 probably does not exceed 1 000 at any time. Feeding is mostly confined to the swarming crustacea of the lower latitudes, and as yet no interaction with the fisheries of area 41 have been recorded.

Tasmacetus shepherdi Shepherd's beaked whale
This species has only been recorded once in area 41 (Mead and Payne 1975), and is very rare worldwide. The stomach contents included hake, serranids and brotulids, all of which groups contain commercial species. The implications of such an apparently rare species eating commercial fish are unclear. On the one hand, there would seem to be little threat to commercial fisheries from such a mammal, but the effects of overfishing a particular

food fish for that mammal on the other hand are unpredictable.

Berardius arnuxii Arnoux's beaked whale
Another relatively rarely seen species, a few individuals have turned up in the Falklands/Malvinas and in Argentina. Stomach contents indicate a diet consisting largely of cephalopods. No interactions with fisheries are reported or likely at present, (Goodall 1977, McCann 1975).

(Mesoplodon densirostris Blainville's beaked whale
This species has not yet been recorded in area 41, but strandings in most other temperate seas of the world indicate that it may occur here. No interactions with fisheries can be envisaged at present.)

Mesoplodon layardii Straptooth beaked whale
Although fairly frequently stranded in New Zealand, this species is only recorded from the Falklands/Malvinas, Uruguay and Tierra del Fuego in area 41 (Goodall 1977, Leatherwood and Reeves 1983). No interactions with fisheries are likely.

Mesoplodon hectori Hector's whale
One of the least known of all cetacean species, this animal has been identified on the basis of very few individuals, one of which was found in Tierra del Fuego (Goodall 1977). It has also been found in the Falkland/Malvinas Islands, and may be circumpolar in all southern hemisphere temperate waters (Leatherwood and Reeves 1983). Nothing is known of its natural history and the most that can be done is to compare it with other beaked whales; interactions with fisheries are unlikely.

Mesoplodon grayi Gray's beaked whale
Although relatively frequently stranded in the southern hemisphere, this species is recorded from only one location in area 41, in Argentina (Goodall 1977). No interactions with fisheries are likely.

Ziphius cavirostris Cuvier's beaked whale
This whale is known in area 41 from strandings in Brazil and Argentina (Watson 1981, Goodall 1977). Although not uncommon throughout the world, interactions with fisheries seem unlikely, partly due to its deepwater habitat.

Hyperoodon planifrons Southern bottlenose whale
This whale has turned up in the La Plata estuary in Argentina, in the Falklands/Malvinas (Watson 1981) and in Tierra del Fuego (Goodall 1977). A diet of squid, coupled with apparent rarity, make this an unlikely species to interact with fisheries.

Physter macrocephalus Sperm whale
Townsend's (1935) maps demonstrate large concentrations of this species on the edge of the shelf in summer months from 10°S to about 50°S. The state of the population in area 41 is unknown but is presumably depleted. A figure of less than, or around, 100 000 individuals may not be unreasonable. No direct interactions with fisheries have been recorded, and would seem unlikely unless oceanic deep sea squid resources become more intensively fished.

(Kogia breviceps Pygmy sperm whale
No strandings have yet been recorded in the South Atlantic, but it seems probable that this species may occur there also; it is at any rate uncommon throughout the world. No interaction with fisheries is likely at present.)

(Kogia simus Dwarf sperm whale
Once again this species has not yet been recorded in the South Atlantic, yet its otherwise worldwide distribution in warmer waters indicates that this is probably merely because of its general scarcity. Interactions with fisheries are improbable at present).

Steno bredanensis Rough-toothed dolphin
Strandings are known from locations in Argentina and Brazil (Leatherwood and Reeves 1983). Nothing is known of the size of the population, nor of any trends in abundance, but the general scarcity of recorded sightings indicates that it is probably a relatively

uncommon species. No interaction with fisheries is known in area 41, though it has rarely been reported in the eastern tropical Pacific tuna fishery as a by-catch (Alverson et al 1972 cited in Mitchell 1975a), so presumably the possibility of interaction with pelagic fisheries exists.

Sotalia fluviatilis Tucuxi
Although commonly seen throughout the range, there is some suggestion that the species is becoming rarer. No estimates are available on the size of the population. Best and da Silva (1984 in press) record about 30 specimens which they collected in two years from fishermen's nets in the central Amazon region, but the effect of this incidental catch on the population is unknown. The diet includes catfish and crustaceans (Mitchell 1975).

(Peponocephala electra Melonhead whale
Although recorded in the mid-Atlantic (Perrin 1976), it has apparently not yet turned up in area 41. This species is presumed rare, and is unlikely to interact with fisheries now or in the future.)

Pseudorca crassidens False killer whale
Hershkovitz (1966) records the distribution of this species from the Caribbean to Buenos Aires. There are neither any hunts nor any interaction with fisheries recorded in area 41, and there is no indication of population size either.

Orcinus orca Killer whale
One recent IWC estimate (Hammond 1983) of the size of the southern hemisphere stock put this as high as about 160 000, but there is no indication as to the distribution of these within area 41. There are no records of any interactions with fisheries in area 41, but these cannot be discounted, as this is predominantly a coastal species, and as conflicts have already arisen in the North Atlantic (see area 27). Indeed in 1978, Goodall and Cameron (1980) report that killer whales were numerous in the Beagle Channel, and were shot at. Presumably fishermen and others in the area regard this species disfavourably already.

Globicephala melaena Long-finned pilot whale
Goodall & Cameron (1980) record the depth charging and killing of 27 adult and 12 young pilot whales at Tierra del Fuego in 1972 by the Argentinian Navy, in the belief that they were killer whales. Although strandings are common, there appear to be no records of gear entanglements or other interactions with fisheries in this area. There are no estimates of abundance for any of the stocks in the southern hemisphere either.

Globicephala macrorhynchus Short-finned pilot whale
No estimates of abundance are available and there are no records of interactions with fisheries in area 41, and again, for such a pelagic species, none are likely at present.

Lagenorhynchus obscurus Dusky dolphin
Goodall and Cameron (1980) report that this species is caught in the north of Argentina in the fine meshed surface nets of the anchovy and mackerel fishery in that area in October and November. As an inshore species, feeding primarily on anchovies (Leatherwood and Reeves 1983) other interactions might be expected but there are no data. There is no estimate of abundance either.

Lagenorhynchus cruciger Hourglass dolphin
Watson (1981) reports seeing these dolphins feeding at the surface on fairly large fish, but nothing more is known of their feeding habits. As yet there are no records of any interaction with fisheries, but this cannot be discounted if fisheries are developed in the more southerly waters of the South Atlantic.

Lagenorhynchus australis Peale's dolphin
Limited to cold coastal waters around the Falklands/Malvinas and from the southern tip of South America to the Gulf of San Matias in Argentina, in parts of which range it is common (Leatherwood and Reeves 1983). Some individuals of this species are evidently caught in the net fishery for 'robalo' (Eleginops maclovinus) in Tierra del Fuego as a by-catch (Goodall and Cameron 1980). The local nature of the population of this species, coupled with its coastal habitat, makes it vulnerable to any expansion in the fisheries

of this area. There is no population estimate, and little is known of its ecology, but Leatherwood and Reeves (1983) report individuals swimming and diving in kelp beds, and found octopus in the stomach of one.

Tursiops truncatus Bottlenose dolphin
Preferring inshore waters, this species is distributed throughout the area as far south as Patagonia. There are reports of this species being caught in small numbers in fishing nets, such as the gill net fishery for Micropogon (croaker) along the central Argentine coast, (Goodall and Cameron 1980). The effect of such by-catch is unknown. Other interactions are not recorded as yet but may yet become more evident.

Grampus griseus Risso's Dolphin
There are no estimates of abundance of Risso's dolphin in area 41, and it is apparently not involved in any interaction with fisheries in this area at the moment. Any offshore development of a squid fishery could perhaps alter this situation.

Stenella longirostris Spinner dolphin
Reported by Perrin et al (1981) from southern Brazil, there are no estimates of the population size in area 41. This species tends to inhabit deeper waters, but may also be found closer to the shore. There is no known interaction with fisheries in this area.

Stenella coeruleoalba Striped dolphin
There is no information on population size or feeding of this species in this area, and no interaction with fisheries has been recorded.

Stenella spp. Spotted dolphin
Again there is a relative paucity of observations on this species in this area, and as yet no interaction with fisheries in this area has been recorded; S. attenuata is the species apparently most affected by incidental catches in the fishery for yellowfin tuna in the Pacific, and like the other species of Stenella could conceivably come into conflict with any development of large scale pelagic fisheries in area 41.

Delphinus delphis Common dolphin
A common species in all warm water areas of the world, no population size estimate is available for this area and there do not appear to be any feeding data for area 41 either. As yet there are no interactions with fisheries in this area.

Lissodelphis peronii Southern rightwhale dolphin
Very little is known of this species which is found primarily in cold offshore waters. There would seem to be little likelihood of any important interactions with fisheries.

Cephalorhynchus eutropia Black dolphin
A relatively rare species whose main area of distribution is along the Chilean coast but which is nevertheless also found (by Goodall 1977) in area 41 around Tierra del Fuego. Leatherwood and Reeves (1983) state that the diet is unknown. A number are known to get caught in fish nets and are used to bait crab traps (Goodall and Cameron 1980), which could have some effect on the population. No data are available on either the size of the population nor on the size of the by-catch.

Cephalorhynchus commersonii Commerson's dolphin
This species is known to be caught in Argentinian waters, incidentally in gill nets, and tangle nets in the fisheries for Eleginops (blenny) and Lithodes (king crab) and also deliberately for crab bait and for human consumption; up to 200 may be taken in these ways each year (Goodall and Cameron 1980). The effect that this has on the population is unknown but could be significant. Leatherwood and Reeves (1983) add that the diet may include squid, cuttlefish, krill, crabs, shrimps and small fish such as sardines, silversides and anchovies.

Phocoena spinipinnis Burmeister's porpoise
Brownell and Praderi (1982) give an acount of this species. Nothing is known about the population size or status, but it is apparently quite often caught in fishermen's nets throughout its range. Brownell and Praderi report 4 as having been caught in the shark gill net fishery in Uruguay over a one year period, and Goodall and Cameron (1980) record

another in the tangle nets for southern king crabs in Argentinian Tierra del Fuego before these were made illegal. Brownell and Praderi found Merluccius hubbsi and Pagrus sedecim in the stomach of one specimen; they also state that this is one of the most abundant coastal small cetaceans in the area. The effect of the by-catch and the fact that this species feeds on commercial fish remains unclear, but Brownell and Praderi suggest that this species is heavily over exploited in area 87 at least.

Phocoena dioptrica Spectacled porpoise
Nothing is known of diet or the size of the population, but fewer than 20 specimens have been recorded (Brownell 1975a, 1976,). It has, however, also been caught in Argentinian tangle nets (Goodall and Cameron 1980), and like P. spinipinnis, may be more common than would at first appear.

Inia geoffrensis Boutu
This species is relatively common in the Amazon river, and until recently was afforded some protection by the superstitions of the local people. Watson (1981) suggests that in some areas in the Amazon this species may help fishermen by responding to their calls and herding fish from deeper waters into their seine nets. Ribeiro (1943 cited in Mitchell 1975a) indicates that in some areas some of these animals were captured for processing into oil. More recently a live capture fishery has developed, and increasing numbers are shot by settlers. There is also a small incidental catch of this species associated with gill net and seine fisheries for catfish (IWC 1977); few data are available on this yet, but Best and da Silva (1984 in press) collected more than 20 specimens from fishermens nets in the central Amazon in a year and a half. The effect of this capture on the population is unknown.

Pontoporia blainvillei Franciscana
The size of the population is unknown, but the species is thought to be fairly common. Stomach samples have yielded about 19 species, mainly fish, of which the majority were a few species including Engraulis anchoita, Cynoscion striatus, Trachurus lathami, and Polyclemus brasiliensis. Incidental catches in shark nets have been common, with between 600 and 2 000 taken per year. This may have had an impact on the size of the population, although more recently this type of shark fishery has been in decline (Brownell 1975, Fitch & Brownell 1971). The proximity of this species to coastal fishing operations is likely to mean that some form of interaction between the dolphin and fishermen is inevitable.

Otaria flavescens South American sea lion
The population size in area 41 is thought to be around 230 000, breeding on the Atlantic coast being confined to islands offshore. Contact with land is thought to be maintained throughout the year, feeding in shallow water often less than 5 miles from the shore. Individuals have been recorded very much further out to sea however. Stomach contents vary from area to area, but include Sebastodes oculatus, Clupea bentinckii, Merluccius gayii, various crustacea, molluscs, and birds, notably penguins. Europeans have exploited the population since around 1520, and commercial exploitation is still carried out by Uruguay and Chile (see area 87), several thousand individuals being killed every year. In addition clandestine exploitation and killing by fishermen impose further mortalities. This species is also known to drown in nets and to cause damage to fishing gear, particularly shore based trammel nets. No quantification of this damage to nets or sea lions is available. Sea lions have also learned to follow boats where they interfere with nets, particularly seine nets, and to take fish from hook and line fisheries. This species is thought to occupy a more inshore habitat than the fur seal (Vaz-Ferreira 1979, 1981, 1982).

Arctocephalus australis South American fur seal
The population is distributed in area 41 south of Sao Paulo in Brazil, breeding on offshore islands including the Falklands/Malvinas; it is thought to be stable or declining at present, although the population in Uruguay has increased in this century, after some heavy exploitation, to a more stable size. These seals feed further out to sea than the sea lions and are therefore less conspicuous near the coast outside of the breeding season. Food items include Engraulis anchoita, Trachurus lathami, Cynoscion striatus, Pneumatophorus japonicus, Peprilus sp. amongst the fish, as well as cephalopods, bivalves and gastropods. Exploitation is both regulated commercially and clandestine. Uruguay has

one of the oldest regulated seal hunts in the world dating back to the early 16th century, and currently takes around 10 000 skins annually. Seals are also killed incidentally in fishing gear, particularly seine nets, and although these seals do not follow fishing boats as their South African relatives do, they still get into both trawl and seine nets at sea. No quantitative data are available on this. No population estimates are available for the whole stock, but the Uruguayan population is estimated at 252 000 in 1972, and the populations in Argentina and the Falklands may total 20 000. (Vaz-Ferreira 1979a, 1982a).

Mirounga leonina Southern Elephant seal
Several small breeding sites exist on the coast of Argentina and in the Falklands/Malvinas; fish and squid have been identified in stomach samples (Laws 1979) but as yet no conflicts are reported.

Leptonychotes weddelli Weddell seal
This is an Antarctic species which is occasionally recorded having wandered northward into area 41 (DeMaster 1979). No interactions with fisheries are likely.

Trichechus inunguis
Apparently confined to the Amazon basin, this species feeds only on plants but has been dramatically reduced in numbers by hunting throughout its range even though this is now illegal in Brazil at least. There may also be a significant number taken as a by-catch in gill nets in the river system (FAO 1978, IUCN 1981).

Of the 47 or so species of marine mammal, quite a high number seem to have the potential to interact, or actually do interact with fisheries, and yet, as regards this particular problem, this is one of the least well documented areas in the world. Seven of the species of baleen whale probably do not feed much in these waters, and at least 13 other species probably feed almost entirely on squid. Leaving aside the potential problems of a squid fishery, there are a further 17 species that are either known to feed on commercial species, or could be likely to include some in their diet. There are a particularly large number of small neritic cetaceans in this area, such as the dusky dolphin, Peale's, Commerson's, and the black and bottlenose dolphins, the spectacled and Burmeister's porpoise and the franciscana, boutu and tucuxi. Many of these are probably caught very frequently throughout the area, which could already be having serious affects on the population dynamics of a number of species, but there are very few data. The paper of Goodall and Cameron (1980) is the only one which addresses this particular problem.

At present few of the fish stocks are over exploited, and it may be that there is little biological interaction; this situation, however, remains unclear.

THE FISH STOCKS OF AREA 41

DEMERSAL FISH RESOURCES

The FAO Atlas of the Living Resources of the Sea (FAO 1981) estimates the total potential yield of demersal stocks in this area to be about 2.5 million tonnes. In 1980 the total demersal catch in area 41 was less than 750 000 tonnes. Most of this was made up from about 4 or 5 species, with one species, Merluccius hubbsi, accounting for about half of the total yield.

MERLUCCIDAE

Merluccius hubbsi Argentine hake
This is the most abundant commercial species between latitudes 34° and 44°S. Averaging 38 and 45 cm in length. It is distributed below 100m on the slope of the continental shelf. South of 47°S, this species becomes replaced by Merluccius polylepis. In 1980 only 370 000 tonnes were taken, mostly by Argentinian, Uruguayan and Brazilian benthic trawlers; this nevertheless represents the largest yield of any species in the area. This species is known to be eaten by a number of marine mammal species.

GADIDAE

Micromesistius australis Southern blue whiting
This species, together with Macruronus magellanicus, form the dominant group numerically between 45° and 55°S. M. australis has an average length of 48-56 cms, and is found in major concentrations between 44 and 52°S. It tends to stay on the slope of the continental shelf between 150 and 500 metres in depth. M. magellanicus tends to shallower water and has major concentrations between 46 and 54°S. CARPAS estimated in 1971 that the potential yield of these two species was about 1.3 million tonnes, M. australis forming 60-70% of this. In 1971 catches of the two species were negligible, but by 1980 78 000 tonnes of M. australis and 7 000 tonnes of M. magellanicus were being taken, almost all by the USSR and Poland. There is little or no reported by-catch in the offshore fisheries.

SCIAENIDAE

Drums and croakers of which at least 6 species are commercially important. These species are found in shallower more coastal waters than the previous species, down to a depth of only about 50 metres, preferring muddy bottoms.

Micropogon spp. Croakers
Caught along all three coasts of area 41, these species are thought to have a potential yield of around 80 000 tonnes, and are probably fully exploited already.

Cynoscion striatus Striped weakfish
This species is found along the South American coast from central Brazil to 42°S, but is only exploited south of 30°, mainly by Uruguay and Argentina. The catch levels are much lower now than they were in the late 1960's, the stock apparently having been overfished. In 1980 the total catch of this species was 25 000 tonnes. Other species of the same genus are fished in Brazil which took 42 000 tonnes in 1980. This species has also been identified in the stomach of Arctocephalus australis.

Micropogonias undulatus Atlantic croaker
There appears to be no estimate of either the initial abundance nor of the potential yield of this stock, but nevertheless in 1980 113 000 tonnes were taken, which makes this species one of the 3 or 4 largest in terms of yields in area 41. The stock is thought to be moderately to fully exploited. Together with the previous species and the sea bass A. brasilianus, this forms the major part of the Uruguayan catch.

Macrodon anycylodon King weakfish
Concentrated mostly on the southern coast of Brazil and along the oceanic coast of Uruguay, this species is thought to have an annual potential yield of about 80 000 tonnes, but currently the catch is around 1 200.

SERRANIDAE

Acanthistus brasilianus Sea bass
One of the most important species to the Uruguayan fishing industry in terms of weight landed. In 1980 a total of 12 690 tonnes of this species were caught. Another 5 000 tonnes of grouper were also landed.

SPARIDAE

Pagrus pagrus Red porgy
This species is distributed mainly between 35° and 41° S, at depths of less than 50 m, or not further than about 60 miles offshore. It would seem to prefer hard-bottomed areas. There is no indication of the potential yield, but currently about 15 000 tones are taken per year.

LUTJANIDAE

Lutjanus purpureus Red snapper
Distributed mostly along the north east continental shelf of Brazil, this stock is largely under-exploited; potential yield is estimated at about 5 000 tonnes and the current catch is about 1 200 tonnes.

ARIIDAE

Marine catfish are usually all considered as one group in the catch statistics. They form one of the major landed catches in terms of biomass, 14 000 tonnes being landed in 1980, all of which was taken by Brazil. They appear to be particularly abundant in the muddy-bottomed Amazon estuary area, but no estimate of potential yield has been made.

OPHIDIIDAE

Genypterus spp. Cusk eels
With a similar distribution to the hakes, these species are found below 100m south of 35°S and below 200m to the south of 41°. There is no indication of potential yield, but in 1980 a total catch of 6 722 tonnes was landed, mostly by Argentina.

CHAELODACTYLIDAE

Chaelodactylus bergi Hawkfish/castaneta
Found on the middle slope of the continental shelf, especially in the south, this species yields around 2 000 tonnes per year, mostly to Argentina. There is no indication of potential yield.

PERCOPHIDIDAE

Percophis brasiliensis Brazilian flathead
Distributed between 50 and 100 m around southern Brazil, Uruguay, and northern Argentina, this stock yields around 2 500 tonnes per year, but once again there is no indication of its potential.

NOTOTHENIDAE

There is no indication as to the potential size of this resource which is distributed in the south of area 41, but foreign fleets, particularly Polish ships, take around 7000 tonnes per year at present.

ELASMOBRANCHS

These include sharks, dogfish, chimaeras and rays, and account for around 20 000 tonnes of landed catch per year. The total potential is unknown. At least two of these fisheries which are coastal are responsible for some incidental catches of marine mammals.

'Miscellaneous marine fish':
This group makes up the 4th largest category of catch. 111 000 tonnes were recorded in 1980, and almost all of this was from Brazil. There is no indication as to the nature of this catch, nor the nature of the fishery.

PELAGIC FISH RESOURCES

The total potential pelagic resources of area 41 are unknown, but may be considerably in excess of 2 million tonnes per year if squid stocks are considered. The anchovy in this

area alone should yield 1 million tonnes, yet the total pelagic yield in 1980 was just over 300 000 tonnes.

CLUPEIDAE

Sardinella brasiliensis Brazilian sardine
Distributed inshore along the Brazilian coast between about 23 and 27°S this stock has seen a steadily increasing catch since the 1960's. In 1971 the catch totalled 110 000 tonnes, in 1977 165 000 tonnes and in 1980 it had reached 210 000 tonnes. This stock has probably now become fully exploited.

Sprattus fuegensis Patagonian sprat
A large stock distributed on the continental shelf off Patagonia and around the Falklands /Malvinas, this remains unexploited at the present. No estimates of the potential yield of this stock have been made, but it is expected to have a potential of several hundred thousand tonnes per year at least.

ENGRAULIDAE

Engraulis anchoita Anchovy
Distributed on the continental shelf from about 33°S to about 45°S and confined to the top 50 metres of water, there are major concentrations of this stock from 35 to 41°S. The virgin stock size has been estimated by CARPAS at around 3 million tonnes and the total mortality rate (Z) at about 0.85; the fishing mortality is very low so this may also be a good approximation to the natural mortality rate (M). The potential yield is estimated in the FAO Atlas of Living Marine Resources (FAO 1981) at 1 million tonnes. Almost all the current catch of between 10 and 20 thousand tonnes is taken by the Argentine fishmeal industry. This species has been found in the stomachs of Arctocephalus australis.

POMATOMIDAE

Pomatomus saltatrix Bluefish
Distributed in the coastal waters of Brazil and Uruguay from the mouth of the Rio Plata to northern Brazil (about 8°N), this voracious predatory fish yields around 10 000 tonnes per year. There is no indication of the potential nor the degree of current exploitation.

MUGILIDAE

Mullets are important locally in Brazil and an annual catch of around 17 - 35 000 tonnes is taken. They are not caught elsewhere in any great numbers and there is no indication of their potential yield.

SCOMBRIDAE

Sarda sarda Bonito
Distributed in two main areas to the south and to the north of the Rio Plata estuary, the latter a breeding area and the former the feeding area. The catch is mostly on the feeding grounds in the summer. In 1980 2 600 tonnes were taken all by Argentina. In the early 1970's Brazil used to take around 1 000 tonnes also but this seems to have stopped. There are no stock size estimates nor estimates of potential yield. Goodall and Cameron (1980) suggest that some dolphins or porpoises may get caught in purse seine nets set for bonito in Argentina.

Scomber japonicus Chubb mackerel
About 9 000 tonnes of mackerel are taken per year, mostly by Brazil. There is no indication as to the potential of this stock, nor the fishing method in Brazil. Goodall and Cameron (1980) however mention the incidental capture of an undetermined number of dolphins, probably mostly Lagenorhynchus obscurus, in fine meshed surface trawl nets used

off the northern coast of Argentina to fish for this species in February.

Tunas

Thunnus atlanticus Blackfin

This species is coastal in its habits, and is distributed around the shelf edge, off the coast of north east Brazil, between about 4 and 6°S, and in another concentration around 13°S. There is no estimate of potential yield, but neither is there any record of this species being fished, so it is presumably underexploited.

The remaining four species all occur in 2 general areas of the south west Atlantic (FAO 1981). The first of these is a large area off the north east cape of Brazil from about 5°N to about 10 or 12°S, and extending out into the mid-Atlantic to around 20°W. The second is a smaller area from about 18 to about 26°S, in a band along the Brazilian coast, well offshore. These species are:

Thunnus alalunga Albacore

A catch of around 8 000 tonnes in 1980, of which Brazil took about 1 000 tonnes, the rest going to 'foreign' fleets.

Thunnus obesus Big eye

A catch of 1141 tonnes in 1980, all of which went to foreign ships.

Thunnus albacares Yellowfin

A catch of 2 661 in 1980, most of which was taken by Brazil.

Katsuwonus pelamis Skipjack

Around 3 000 tonnes taken in 1980, of which 2/3 was taken by Brazil.

CARANGIDAE

Seriola spp. Amberjacks

A small fishery exists in Argentina, of around 200 tonnes per annum, but Uruguay is also apparently expanding its Seriola fishery. This is the same genus of fish which is involved in the Iki Island dolphin controversy, although in that instance the use of hooks and lines is largely responsible for the conflict (See area 61).

INVERTEBRATE RESOURCES

CEPHALOPODA

The total potential of this resource is unknown but the biomass is thought to exceed 3 million tonnes. The current catch is around 30 000 tonnes, of which 2/3 are Loligonidae and Ommastrephidae. The fishery has expanded massively in the last 4 or 5 years, and presumably will continue to grow. The greatest known concentrations at the present are on the edge of the continental shelf off the Rio Plata estuary, and on the Patagonian shelf around 45°S.

THE FISHERIES OF AREA 41

Of the three countries with coastlines in this area, Brazil has the largest recorded catches, of around 850 000 tonnes in 1980. Over 130 000 tonnes of this is freshwater fish, largely characins and catfish from the Amazon which are caught in gill and seine nets. These nets are also responsible for the incidental capture of an unknown number of Inia geoffrensis and Sotalia fluvescens.

Over 200 000 tonnes of sardine are also caught, presumably by surface trawl or seine nets. This occurs in the south of the country in inshore waters, and also presumably represents the possibility of some interaction with marine mammals in the area, although this has not apparently been documented. Unlike its South African relative, the local fur seal does not apparently follow sardine boats, but this does not preclude some conflicts

arising.

The relatively large catches of marine catfish, and of other coastal species which are locally important, such as the mullets, suggest that artisanal fishing may play an important role in the Brazilian fishery, in which case interactions with marine mammals might be expected more frequently than if benthic trawling were the most important type of fishery.

Over 100 000 tonnes of miscellaneous fish are also taken by the Brazilians, but there is no indication how this catch is taken, neither is there any other apparent documentation of interactions between marine mammals and fisheries in Brazil. Brazil, however, does make an annual catch of about 900 minke whales and also a few sperm whales.

Uruguay has an annual catch of around 120 000 tonnes, mostly marine fish. The Uruguayan fishing fleet is apparently largely composed of industrial boats, chiefly trawlers taking two species of Sciaenid from the mid-shelf area and also the sea bass Acanthistus. These types of fishing operation are usually less likely to involve interactions with marine mammals.

There are also, however, a number of fisheries operating in the Rio Plata estuary on a smaller scale. These include the gill net shark fishery which annually takes several hundred Pontoporia blainvillei, although this shore based fishery is now giving way to a boat fishery for sharks which may reduce the incidental catch of Pontoporia and other dolphins.

Uruguay also takes an annual 9 or 10 000 fur seals, but despite the hundreds of thousands of these animals breeding on offshore islands in this region, there appears to be relatively little conflict with fisheries.

Catches by Argentina amounted to some 350 000 tonnes in 1981. This represents a drop from 560 000 tonnes in 1979, though the general recent trend in Argentine catches has been upward. Goodall and Cameron (1980) state that "The fishing industry is being rapidly developed in Argentina, with ample government support, and the next few years should see more open sea fishing with large boats. Inshore fishing is unlikely to increase." As they also point out it is the inshore fisheries that are more likely to cause mortality to marine mammals, and it is also these types of fishery which most often see marine mammals as competitors. Open sea conflicts are more likely to arise where a stock is being heavily exploited and thereby affecting the feeding of marine mammal populations, such interactions are unlikely in this region at present.

Inshore fisheries include those for hake, smelt, anchovy, sea bass and chimaeras along the coast around Mar del Plata. In this area also fisheries for anchovy and for mackerel using fine meshed surface trawls are known to catch some dolphins. There is also a purse seine fishery for bonito which is known to have had dolphins in the nets in the past. In the La Plata estuary there is a gill net fishery for Micropogon (croaker) which is also known to take dolphins occasionally, which may then be prepared for human consumption. Some dolphins, possibly up to 100 Cephalorhynchus commersoni, may also be taken by the gill net fishery for Patagonian blenny in the Province of Santa Cruz. In Tierra del Fuego there are shore based fisheries for Eleginops and for Lithodes, the southern king crab. Until 1976 both of these species were caught using long tangle nets. These nets used to trap at least 4 species of small cetacean. Since 1976 this practice has been banned in the Lithodes fishery, and only traps are used. The tangle nets are still used for the capture of Eleginops and P. spinipinnis, P. dioptrica, C. commersonii, and L. australis are all still accidentally caught in this manner.

Sea lions and fur seals are also known to get into purse seine nets for pelagic fish, and also into the nets of smaller trawlers. This presumably also occurs in both Uruguay and Brazil to some extent.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 41

Operational interactions

1 An unknown number of Inia and Sotalia are caught in gill nets and seine nets in freshwater fisheries in Brazil. Some of these animals are also taken deliberately for food, and the suggestion is that as the Amazon becomes more populated these problems are becoming worse.

2 The shark fishery in Uruguay yields several hundred Pontoporia per year as a by-catch. Other species are also known to be caught in these nets, including Otaria and Arctocephalus australis. The status of the Pontoporia population is unknown, but given the size of the incidental catches, these could have significantly affected the population. The populations of Otaria and Arctocephalus have probably not been affected as the catches are fewer and the populations larger. This problem may decline as less fishing is done for sharks from the shore, and more at sea from boats where Pontoporia is less numerous.

3 Along the Argentinian coast fisheries for a number of species, including purse-seine fishing for bonito, midwater trawling for mackerel and for anchovy, and gill net fishing for croakers and also for Patagonian blennies all have incidental catches of a number of cetacean species. These include Pontoporia, Phoecoena dioptrica and P. spinipinnis, Lagenorhynchus obscurus and L. australis, Cephalorhynchus commersonii and possibly Tursiops and Stenella spp. The numbers of these species caught are unknown, but are probably few. There does not seem to be any expansion in these coastal fisheries and so no increase in interaction can be expected, unless the abundance of either the fish species or the dolphin species changes markedly.

4 In Tierra del Fuego a number of small cetaceans are known to be taken in tangle net fisheries. Goodall and Cameron (1980) give figures suggesting that about 100 animals, P. spinipinnis, P. dioptrica, C. commersonii and L. australis were known to have been taken in tangle nets for crabs and blennies between 1975 and 1979. Nearly 3/4 of these were C. commersonii, and the actual numbers may be considerably higher. Since 1976 tangle nets for crabs have been banned, but on at least one occasion fishermen have harpooned dolphins to bait crab traps which have replaced the nets, though this is illegal in Argentina. The numbers of animals killed in this way should have declined since 1976, but there are no comprehensive data.

There is no information on either the extent of damage done to gear by marine mammals in area 41, nor on damage to catch. Inasmuch as most operational interactions appear to be accidental drownings, it is possible that damage to catch is minimal. Presumably however there is some degree of damage to nets whenever a marine mammal becomes entangled.

Biological interactions

There are no documented cases in this area of marine mammals being deprived of food due to heavy fishing, possibly as few stocks are heavily exploited. There is one instance on record of fishermen in Mar del Plata, Argentina, becoming alarmed at a large number of dolphins being seen in the area. According to Goodall and Cameron (1980) they assumed these were frightening away the schools of mackerel and asked the navy to eliminate them. Argentinian scientists were able to argue in support of the dolphins however and the navy did not intervene. Nevertheless it is possible that some dolphins have been killed in this or possibly other similar incidents. In general it would seem that the abundance of fish in this area may help to reduce the likelihood of fishermen being deprived of fish due to excessive numbers of marine mammals. Few of the commercially caught species have been found in stomachs of marine mammals, but this may be simply a reflection of the paucity of such data.

3.8 AREA 47: SOUTHEAST ATLANTIC

MARINE MAMMALS FOUND IN AREA 47

Eubalaena glacialis Right whale
The whaling maps of Townsend (1935) show that large concentrations of this whale were to be found between 30 and 40°S, west of the Cape of Good Hope. Another, smaller ground, the Woolwich Bay Ground, was found off the coast of Namibia, presumably a breeding area. The Report of the IWC Right Whale Workshop (1983) indicates a possible Southern African population in 1980-82 of 478-614 whales. This species does not consume fish (Tomilin 1967), but entanglement in coastal fishing gear is a potential problem, of which at least one instance is already known (Report of the Right Whale Workshop, IWC 1983).

Caperea marginata Pygmy right whale
Ross et al (1975) found 71 recorded individuals of this species by 1975, and there do not appear to be any other indications as to the possible size of the population. Best (1977) records the incidental capture of 3 animals in beach seining operations, fishing for mullet, but states that this practice has probably stopped now. Ross et al also report the incidental capture of 2 individuals in beach nets. The food is thought to consist mostly of copepods (Ivashin et al 1972), and no other interactions with fisheries are likely.

Balaenoptera physalus Fin whale
This species is known to migrate from Antarctic waters to the coasts of South Africa and Namibia to breed in the winter (Tomilin 1967). Best (1967) found about 36% of fin whales in South African whaling grounds were feeding, 94% of the diet was euphasiids, and the rest copepods and amphipods. No fish were found. There is no clear indication of the numbers of fin whales to be found in area 47, but this is presumably in the low tens of thousands.

Balaenoptera musculus Blue whale
The blue whale also migrates to area 47 to breed from Antarctic waters, but again in unknown numbers, presumably in the hundreds or low thousands. Blue whales do not consume fish in the southern hemisphere, and do not feed at all in the winter months (Nemoto 1959, Mackintosh 1965), so there are unlikely to be any interactions with fisheries.

Balaenoptera acutorostrata Minke whale
Hershkovitz (1966) states that the minke whale occurs from the Cape of Good Hope, south to the Antarctic Ice Shelf, but it is presumably found north of the Cape also. Best et al (1983) saw three off the South African coast in a sightings cruise in 1983, and Tomilin (1967) states that minke whales are also found in tropical waters, although rarely. Tomilin adds that the diet is mostly pelagic crustacea in the southern Oceans. There is no clear indication of the likely numbers of minke whales which migrate into area 47, but this may be in the hundreds of thousands. Interactions with fisheries are unlikey, due to the diet of crustacea.

Balaenoptera borealis Sei whale
In common with other baleen species, the sei whale migrates to the coastal waters of south western Africa in the winter months. Again, population estimates are crude, but between a few thousand and a few tens of thousands of animals are probably involved. Although known to eat fish elsewhere, Best (1967) found that, of the whales he examined, about 50% were feeding; of these about 70% of the food was euphasiids, and about 30% copepods. Only about 0.2% of the diet (by volume) was found to be fish.

Balaenoptera edeni Bryde's whale
Bryde's whale is less inclined to wander southward to the Antarctic in this area, and may be found throughout the year in South African waters, apparently not straying further south than around 40°S (NCC 1980). Two stocks of this species, an inshore and an offshore form, are recognised around South Africa, (Best 1977a). Best (1967) found that overall, Bryde's whales in South African waters consumed 47% fish and 53% euphasiids. Of the fish, most was Engraulis and Trachurus, with some Sardinops ocellata and Lestidium sp.. Best (1977a) suggests that the inshore form eats mainly fish, especially Engraulis capensis, Trachurus capensis and Sardinops ocellata, but also some euphausiids,

and that the offshore form prefers euphausiids, but eats some fish. Best et al (1983) suggest that the inshore stock may total around 500 animals. There do not appear to be any estimates of the offshore stock. Due to the intensive purse-seine fishery for anchovy and other pelagice species in this area, the distribution and abundance of the inshore stock could be influenced by changes in the fish stocks.

Megaptera novaeangliae Humpback whale
Known to migrate to waters off the coast of Angola (Tomilin 1967), Townsend's (1935) whaling maps clearly show a dense distribution of catches in that area. Tomilin (1967) states that the diet of this species in southern oceans consists of Krill, but that in winter some individuals may feed on the pelagic decapod Munida gregaria. Mackintosh (1965) suggests that winter feeding in humpbacks is negligible. The population size in this area is unknown at present, but unlikely to exceed a very few thousand at most.

Berardius arnuxii Arnoux's beaked whale
Confined to waters further south than 30°, (McCann 1975). Very little is known about its biology or population size. It is thought to feed on squid, and is very unlikely to come into conflict with fisheries.

Mesoplodon densirostris Blainville's beaked whale
Ross (1979) records this species from South Africa. Interactions with fisheries are unlikely.

Mesoplodon layardii Strap-toothed whale
Recorded by Leatherwood and Reeves (1983) from South Africa, little more information than this is available. Interactions with fisheries are unlikely.

Mesoplodon hectori Hector's beaked whale
Again recorded by Leatherwood and Reeves (1983) from South Africa, very little is known of this species and the likelihood of interactions with fisheries is very small.

Mesoplodon grayi Gray's beaked whale
As with the two previous species, this whale is recorded from South Africa by Leatherwood and Reeves (1983) and interactions with fisheries are unlikely.

Mesoplodon mirus True's beaked whale
Individuals are known from South Africa (Leatherwood and Reeves 1983), but the distribution of this species remains unclear. There may be a separate stock here or else the species may range over much of the Atlantic. No interactions with fisheries are likely.

Ziphius cavirostris Cuvier's beaked whale
Another little known species, Mitchell (1975) refers to strandings as far south as the Cape of Good Hope. There is no indication of population size in this area, nor of the diet, which may be presumed to be squid or deepwater fish. No interactions with fisheries are likely.

Hyperoodon planifrons Southern bottlenose whale
Recorded from South Africa (Mitchell 1975), but apparently confined to more southerly regions, little is known of this species, and interactions with fisheries are unlikely.

Physeter macrocephalus Sperm whale
An extensive year round concentration of sperm whales appears on Townsend's (1935) whaling maps (the Carroll Ground) off the coast of Angola, and a smaller ground around Tristan da Cunha. The current numbers of sperm whales in area 47 are unknown, but may be in the hundreds of thousands. Feeding is almost exclusively on squid, and no biological interactions with fisheries are likely.

Kogia breviceps Pygmy sperm whale
Tomilin (1967) suggests that this species is mainly a warm water species, but that its range extends down as far as the Cape of Good Hope. Records are scarce however, and knowledge of the diet scanty, but this is presumed to consist mostly of squid. Interactions with fisheries are unlikely.

Kogia simus Dwarf sperm whale
Ross (1979) records this species in South Africa. It is uncommon worldwide and interactions with fisheries seem unlikely.

Steno bredanensis Rough-toothed dolphin
Few data have been published on this species, but it is known from strandings in South Africa (Leatherwood and Reeves 1983). Mitchell (1975) suggests that food, in general, is likely to be fish, although some of the few data available show a diet of cephalopods (Layne 1965, Cadenet 1959). There are no feeding or abundance data published on this species in area 47 and no interactions with fisheries are likely.

Sousa chinensis Indo-Pacific hump-backed dolphin
Distributed from near the Cape of Good Hope up the east African coast (Mitchell 1975), the population size is unknown. Saayman and Taylor (1973) state that Sousa is a fairly solitary species, feeding over reefs and rocky outcrops, often near breaking waves, and that the population is dispersed. There does not seem to be any published data on feeding, although there is some suspicion that in area 51 this species is caught in shark nets while following pilchard schools (IWC 1982 p207-208), otherwise food species might be expected to include rocky bottom species of this area. There do not appear to be any records of interactions between this species and commercial fisheries in the southern limits of its distribution as yet.

Sousa teuszii Atlantic hump-backed dolphin
The Atlantic humpbacked dolphin is thought to extend to the coastal waters of Angola, (Mitchell 1975), although its main area of distribution is further north. The population in area 47 is therefore presumably small, and although no interactions with fisheries are reported, the artisanal coastal fisheries of Angola (FAO 1981a) make some such interactions probable. Food is unknown in this region.

Peponocephala electra Melon-headed whale
Not a common species in this area, it may normally be confined to an area north of 10°S (NCC 1980), one individual however has been recorded in South African Waters (IWC 1978). Almost nothing is known of their feeding anywhere and there are no likely interactions with fisheries in this area.

Feresa attenuata Pygmy killer whale
This species has been recorded infrequently from South Africa (Caldwell & Caldwell 1971a), and nothing is known of its diet or population size in this area. Interactions with fisheries would seem unlikely at present.

Pseudorca crassidens False killer whale
Tomilin (1967) states that South Africa represents the southern limit of the distribution of this species, and Mitchell (1975) adds that it prefers offshore waters. There are no population estimates for this species, nor feeding data in this area, although it is generally known to eat fish. No interactions with fisheries are apparent at present, but this situation could change as commercial species (Carangids) are known to be included in the diet elsewhere.

Orcinus orca Killer whale
Widespread and relatively common worldwide, there are nevertheless no abundance estimates for area 47. Budylenko (1981) suggests that the diet of the killer whale in the South Atlantic is predominantly dolphins and fish. Interestingly, despite fairly heavy fishing operations in area 47, killer whales do not seem to have been reported in any interactions with fisheries here. Best (pers. comm.) however reports some interaction with tuna fishermen, both sport and commercial, off the Western Cape Province.

Globicephala melaena Long-finned pilot whale
Mitchell (1975) states that this species occurs from the Antarctic convergence, north with the Benguela current. There are no population estimates of this species in this area. The diet is known to consist of cephalopods almost everywhere it has been studied. There appear to be no reported interactions with fisheries, nor would any seem likely.

Globicephala macrorhynchus Short-finned pilot whale
Mitchell (1975) describes the distribution of this species as extending down as far as 15°S on the Angolan coast. Ross (1979), also records it from the south east coast of South Africa. There do not appear to be any data on feeding habits nor population size in this area however, and no records of interactions with fisheries either.

Lagenorhynchus obscurus Dusky dolphin
Distributed throughout the cooler and temperate waters of this area, the dusky dolphin is said to prefer inshore waters (Mitchell 1975). There are no abundance estimates, although during a 3 week cruise in 1983, Best et al (1983) report sighting of 94 individuals. Food of this species is uncertain, but Best (1977) reports that it is caught incidentally in the purse seine fishery for Engraulis capensis and Trachurus capensis which may indicate something as regards diet. Best suggests that around 100 animals of possibly 4 cetacean species are caught in these purse seine fisheries per annum. Lagenorhynchus species elsewhere are also known to feed on schooling pelagic commercial fish species, and these are possibly amongst the marine mammals most likely to be affected by interaction with commercial fisheries. No further data on the problem exist however.

Lagenorhynchus cruciger Hourglass dolphin
A pelagic species, confined to colder waters, little is known about the population or diet of this species, and there do not appear to be any records of interactions with fisheries.

Lagenodelphis hosei Fraser's dolphin
Ross (1979) has recorded this species from the south eastern coast of South Africa, but there seem to be no records of interactions with fisheries.

Tursiops truncatus Bottlenose dolphin
Apparently fairly common throughout the area, Best et al 1983 report sighting 56 individuals during a 3 week cruise of South African inshore waters. However, no estimates of abundance are available for this area. Best (1977) reports the probable incidental capture of this species in the purse seine fisheries for anchovy and horse mackerel in area 47, which appears to be the only indication of feeding or of interactions with fisheries for this area. It would seem likely that other incidental captures occur, but as yet have not been reported.

Grampus griseus Risso's dolphin
Found in warm and temperate waters as far south as South Africa (Tomilin 1967), this is not a particularly common species anywhere. Nevertheless, Best et al (1983) report seeing 143 individuals in a 3 week cruise in inshore South African waters. There do not appear to be any reports of incidental captures of this species in this area yet, and predatory interactions are unlikely if the food is primarily cephalopods (Mitchell 1975).

Stenella longirostris Spinner dolphin
Reported to be present from Senegal to the Cape of Good Hope (Mitchell 1975), there are no indications of population abundance or of any interactions with fisheries in this region. Food could presumably be small mesopelagic fish and epipelagic and mesopelagic squids as described by Perrin et al (1973), in which case, in the absence of incidental captures in tuna seining operations, there may be no liklihood of any immediate interactions.

Stenella coeruleoalba Striped dolphin
The striped dolphin is apparently more common in South African waters than the spinner in the summer at least; Best et al (1983), report sighting 100 individuals of this species in a 3 week cruise in the coastal waters of South Africa, and none of the previous species. The food in this area is unknown, but may be small mesopelagic fish as elsewhere (Miyazaki et al 1973). There are no reported interactions with fisheries at present.

Stenella attenuata Spotted dolphin
Again there are no estimates of population abundance or feeding of these species in this area. There are no interactions with fisheries at present, which for these species generally means no dolphin-associated tuna purse seining in the area.

Delphinus delphis Common dolphin
This species appears to be very abundant in this area, being the species most commonly sighted by Best et al (1983); 1 585 individuals were counted in a 3 week period in inshore waters of South Africa. Food of this species is often small pelagic fish, frequently commercial species, so it is not surprising therefore that Best (1977) reports D. delphis as an incidental catch in the purse seine fishery for anchovy, and for horse mackerel. Best estimates less than 100 are killed in purse seines per year in this manner. There are no further data on any other interactions with fisheries, but these may be considered possible.

Lissodelphis peronii Southern right whale dolphin
Cruickshank and Brown (1981) and Brown (1982) give details of 8 sightings of this species in the waters around South Africa. It is a pelagic species, not often observed, and there are no population estimates. Food is unknown, but Cruickshank and Brown (1981) found lantern fish, euphausiids, and small squids were abundant in the same region as the rightwhale dolphins. No interactions with fisheries are reported from this area, and are not likely to be significant.

Cephalorhynchus heavisidii Heaviside's dolphin
Confined to the coastal seas of South Africa and Namibia, from Cape Town to Cape Cross (Mitchell 1975). The population size is unknown, but Best et al (1983) report sighting 38 in a 3 week cruise of inshore waters. Food is also unknown, but thought to be squids and bottom dwelling fish (Mitchell 1975). Best (1977) reports that some of this species may be caught incidentally in the anchovy and horse mackerel fisheries of the region. The South African Progress Report to the IWC (1979) also states that 2 individuals were caught by a Portuguese stern trawler. The extent of interactions between this species and commercial fisheries is therefore unknown, but some possibly significant interaction does occur.

Arctocephalus pusillus Cape fur seal
The African subspecies breeds on offshore islands and along the coasts of Namibia and South Africa, from 11°S on the west coast to 33°S on the south east coast. Definite migrations are not known, but individuals have been recorded up to 100 nm out at sea (Shaughnessy 1979, 1984 in press). The total population has been estimated at 944 000 individuals, and is thought to be still increasing (Shaughnessy 1984 in press). There is a cull which amounts to around 78 000 pups and 2 200 bulls (Shaughnessy 1979). Market conditions forced a substantial drop in this in 1983 (Best, pers. comm.). There is some considerable interaction between this species and commercial fisheries of the region. The situation is described in detail by Shaughnessy (1984 in press). There is some damage to fishing gear, trawl nets and possible seine nets too, but Shaughnessy suggests that this does not amount to much. A more major problem comes with interference in purse seining operations, where hundreds of seals may move into the encircling net to eat the fish, causing a nuisance and consuming catch. There is some disturbance in trawl nets and hand line fisheries too; Shaughnessy & Payne (1979 cited in Shaughnessy in press) estimate that around 4 000 seals are killed in trawls, and Shaughnessy (in press) suggests an indeterminate number are also killed by seining operations. Rand (1959) also noted the habit that fur seals have of eating fish protruding from trawl nets, and occasionally becoming trapped in the cod end as the trawl is raised to the surface. Such seals are killed when the net is shot away again, or when they come on board. Fur seals will follow fishing boats, and are often attracted by the fish offal discarded over the side. Rand (1959) found that schooling fish, notably Sardinops ocellata, Trachurus trachurus and Scomber japonicus made up 80% by volume of the fish food. Fish formed 60% of the diet, with crustaceans and cephalopods making up the remainder. Anchovy was found to comprise only 2% by volume of the diet. Rand noted year to year fluctuations in the relative quantities of the different species eaten. Shaughnessy, however, found that the main food items in 1975 were the bearded goby (a non commercial species) and horse mackerel, whilst anchovy was also fairly common but pilchard rarer. The change in diet, Shaughnessy suggests, may be due to a shift in species composition under the influence of commercial fishing. The effect that the fisheries have on the seal population in this area may not, therefore, be significant in terms of loss of food; whether the same can be said of the effect of seals on fisheries remains to be seen.

Arctocephalus tropicalis Subantarctic fur seal
The population in area 47 breeds at the Tristan da Cunha - Gough Island group, and may have numbered around 13 000 animals in the 1950s (Swales 1956, cited in Shaughnessy 1979); Shaughnessy (1979) suggests the population may have increased since then, Rand (1956) also showed that the food of this species is largely Nothothenid fish, cephalopods, and euphausiids. There do not appear to be any interactions with fisheries, which are not very active in these regions, and there is no culling of this stock.

(Hydrurga leptonyx Leopard seal
Occasionally straggling northwards to this area (Hofman 1979), there are no interactions with fisheries.)

Trichechus senegalensis West African manatee
Occurring as far south as Angola, this species is found only in the very north of area 47 (Husar 1978). As in the rest of its range, accidental capture in fishing nets is likely to cause some additional mortality to an already depleted stock, but no data are available for this (See also area 34).

Of the 40 or so species of marine mammal found in this area, only a few are involved in any interactions with fisheries. 6 species of baleen whale do not consume fish in this area. The seventh species is known to eat some commercial fish, including pilchards, anchovies and horse mackerel. At least another 9 species are not well enough known to establish their diet in this area and at least 12 more species feed wholly or mostly on cephalopods. The diets of the remaining 12 species are not all well known either.

The dolphins of the genus Stenella and the subantarcic fur seal are thought to feed on small non-commercial fish species and squids, as is the right whale dolphin; the killer whale is thought to feed on marine mammals. The only other species with any information on their diets in this area are the Indo-Pacific hump-backed dolphin, which may eat pilchards, the few delphinid species which might be assumed to eat anchovies and pilchards, such as the common dolphin and the dusky dolphin and possibly the bottlenose dolphin too, and the fur seal and manatee, the former of which eats gobies and horse mackerel, and the latter only plant matter.

THE FISH STOCKS OF AREA 47

DEMERSAL FISH RESOURCES

The principle stocks of demersal species in this area are hakes, which make up the bulk of the catch, and a few other species such as kinglip (Genypterus) and seabreams (Sparidae), but the number of species caught is relatively few. The total catch of demersal species in 1981 totalled 450 000 tonnes. This represents a considerable drop from the peak of approaching 1 million tonnes in 1976, due largely to the over-exploitation of hake. Demersal fish are not apparently important in the natural diet of any species of marine mammal in this area.

GADIDAE

Merluccius capensis and M. paradoxus
A trawl fishery for these species includes large long-range vessels from a number of foreign fleets. Several stocks may exist in the area, but the stock relationships are not yet entirely clear (ICSEAF 1982). Gulland (1983) states that the stocks are heavily fished, with effort currently exceeding that which would produce an MSY by a wide margin, current catches totalling around 300 000 tonnes (in 1981), a drop from 800 000 tonnes in 1976 (FAO 1983).

There are some reported by-catches of marine mammals in trawl nets, 2 Cephalorynchus heavisidii having been reported in 1979 (S. Af. Prog. Report to IWC, 1979), and fur seals are also known to get caught in trawl nets (see above). It would seem probable that other incidental catches may occur, but go unreported. There seem to be no records of marine mammals eating hake, apart from the fur seals, so that an overexploited stock may not be

having any great impact on marine mammal feeding.

Other stocks.
Other stocks of demersal fish in the area produce, by comparison, very small catches. In the more northerly regions off Namibia and Angola, hakes are replaced by grunts, croakers and basses, the largest catches being less than 10 000 tonnes for any one species. Most of these appear to be taken by small scale inshore fisheries (FAO 1981a) and their status is unclear.

PELAGIC FISH RESOURCES

The total pelagic catch in 1981 slightly exceeded 1.7 million tonnes. The number of species of importance exceeds those in the demersal fishery, with pilchard, horse mackerel, anchovy and sardinellas all being important components.

CARANGIDAE

Trachurus capensis and Trachurus trecae horse mackerels
Trawlers from a number of foreign countries as well as local purse seiners take more than half a million tonnes a year of these species. Stocks are distributed around the coast from Natal to southern Angola. Catches may be approaching or exceeding the MSY at present, and the decline of the pilchard stocks may have been one factor causing the recent increase in horse mackerel stocks (FAO 1981a). Best (1977) suggests horse mackerel purse seiners may take around 100 small cetaceans a year, incidental to the catch. Horse mackerels are known to be eaten by cape fur seals.

CLUPEIDAE

Sardinella spp Sardinella
Distributed mainly in more northerly coastal waters, the sardinella yielded around 160 000 tonnes in 1981, (FAO 1983), down on the previous two years, but the total potential and state of the stocks are unknown.

Sardinops ocellata Pilchard
Under 100 000 tonnes were taken in 1981, following the collapse of the Namibian stock in the 1970's (FAO 1983). Distributed mainly off Namibia and the west coast of South Africa, this species still remains an important part of the local purse seine fishery.

Engraulis capensis Anchovy
Catches in excess of half a million tonnes have been reported in the late 1970's, but in 1981 the catch fell to 490 000 tonnes (FAO 1983). The anchovy stocks appear to have benefitted from the collapse of the pilchard stocks. Best (1977) referred to the incidental capture of a few small cetaceans in this fishery. This species, and the preceding one may feature in the diet of a number of dolphin species

Other Stocks
Other important fisheries include a hand line fishery for snoek (Thyrsites atun), which is known to be hindered by fur seals occasionally, and which took 25 000 tonnes in 1981. There are also other species involved in the purse seine fishery, including mackerel (Scomber japonicus) of which 24 000 tonnes were taken in 1981 (FAO 1983). Tuna are also important, although no interactions with dolphins have been reported here yet.

INVERTEBRATE RESOURCES

CEPHALOPODS

The total catch of all species is just over 8 000 tonnes in 1981, most of which were loligonids and ommastrephids, Voss (1973) refers to Rand's assessment of squid stocks of the region and suggests that a figure of several hundred thousand tonnes potential yield may not be unreasonable.

The lobster fishery should also be mentioned as an important commercial operation (7 000 tonnes in 1981), but one which does not appear to have any direct impact on marine mammals, or vice versa, at present.

THE FISHERIES OF AREA 47

Newman (1977) has reviewed the fisheries of the region, while Shaughnessy (1984 in press) has discussed their relation to marine mammals. Rather more than half the catch is taken by large foreign trawlers, fishing mainly for hake, horse mackerel and sardinella. Since the period reviewed by Newman, most foreign vessels have left South African waters, following the extension of the limits, though foreign fleets still fish off Namibia and, by arrangement, off Angola.

Locally based fisheries employ trawlers (mostly for hake and kinglip), and purse seiners (for pilchard and anchovy), as well as a variety of other gears from small vessels off South Africa and Angola.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 47

Operational interactions

Gear conflicts as reported are limited in the number of marine mammal species involved. The most dramatic is that of the fur seals which cause severe nuisance in purse seine fisheries, and in trawl and handline fisheries.

1 Pygmy right whales have been reported in beach nets.

2 Dusky dolphins, common and Heaviside's dolphins have all been reported in seine or trawl nets in small numbers.

3 Bottlenose dolphins are thought likely to be caught in similar cases, though there appear to be no records at present.

4 Fur seals cause the most dramatic nuisance to fishermen by invading purse seine nets, and taking fish from trawls.

Biological interactions

There has been some criticism of fur seals in this respect, but Shaughnessy (1984 in press) suggests that there may have been a change in the diet of these species to reflect the change in fish species abundance. Undoubtedly, however, some commercial fish are still eaten, and this may still be seen as a problem in some quarters.

Potential problems exist in the number of marine mammals which feed on squid, a resource which is at present greatly under-utilized in this area. Any increase in the size of the Bryde's whale stocks in inshore waters around South Africa may also lead to some conflict as this species is known to consume commercial species. Finally some of the dolphin species could also be affected by the reduction in biomass of some of the stocks of small clupeids. The common dolphin in particular, which appears to live up to its name in this area, could also be seen as a competitor with commercial fisheries in this respect.

3.9 AREA 51: WESTERN INDIAN OCEAN

MARINE MAMMALS FOUND IN AREA 51

Eubalaena glacialis Right whale

Townsend's (1935) whaling maps show three or four whaling grounds for this species in the south of area 51, and Marcuzzi and Pilleri (1971) show the range extending as far north as Mozambique on the East African coast. No data are available on the size of the population in area 51, but this may number in the hundreds. No interactions with fisheries are likely.

Caperea marginata Pygmy right whale
Ross et al (1975) describe the distribution of this species, which includes area 51, south of about 31°S. Sightings of this species are sparse, and although it has turned up in nets in South Africa (see area 47), interactions with fisheries are unlikely.

Balaenoptera physalus Fin whale
Tomilin (1967) states that fin whales migrate from the Antarctic to Madagascar, but that bones of fin whales have also been found in the Red Sea. Keller et al (1982) also found fin whales present around the Seychelles and give other records from the Indian Ocean. There are no reliable population estimates of this species in area 51, and no data on feeding. However, the population could be in the thousands or tens of thousands, and feeding on anything other than swarming crustacea is unlikely. No interactions with fisheries are recorded or likely.

Balaenoptera musculus Blue whale
Observed as far north as the Gulf of Aden (Yukov, 1969 cited in Keller et al 1982), Tomilin (1967) states that part of the Antarctic population moves north to Madagascar in winter. The population size is unknown, but is possibly in the thousands. There are no known interactions with fisheries in area 51 and none seem likely.

Balaenoptera acutorostrata Minke whale
Tomilin (1967) states that this species is rare in the tropics but has been found in Ceylon. Gambell et al (1975) also record minke whales in this area. The population size is unknown but may number in the tens or even hundreds of thousands. Feeding in this area is also unknown; Tomilin (1967) and Nemoto (1970) both characterise the minke whale in Antarctic waters as a euphausiid eater, but it is unclear whether there is any feeding in more northerly waters. There are no records of interactions with fisheries in area 51.

Balaenoptera borealis Sei whale
Budylenko (1978) summarizes information on this species in the Indian Ocean. Sei whales are widespread throughout the area, and have been observed throughout the year. Feeding is presumably confined to swarming crustacea such as Calanus (Budylenko 1978). There are no estimates of the population size in this area but this may be in the thousands. No interactions are recorded or likely.

Balaenoptera edeni Bryde's whale
Present in tropical and temperate waters throughout the Indian Ocean, Ohsumi's (1981) analysis suggests a population size in area 57 in excess of 10 000 animals. The diet is known to include small fish and so some interaction with fisheries is probable, though as yet unreported. Leatherwood et al (1983) report one individual feeding on a school of fish, presumed to be mackerel.

Megaptera novaeangliae Humpback whale
Marcuzzi and Pilleri (1971) give breeding sites of this species, including areas of Mozambique and Madagascar. Humpbacks are also known from the Gulf of Aden (Yukov, 1969 cited in Keller et al 1982). The current population size is unknown but may only number in the hundreds in this area. There are no records of fish consumption, nor any interactions with fisheries.

Berardius arnuxii Arnoux's beaked whale
Leatherwood and Reeves (1983) describe the distribution of this species as almost certainly including the Southern Indian Ocean. Other references to area 51, seem to be very sparse. The population size is certainly unknown, and interactions with fisheries unlikely.

Mesoplodon pacificus Longman's beaked whale
Possibly the least known cetacean species. One of the two known specimens comes from Somalia (Azzaroli, 1968) so the distribution is inferred to include area 51. Keller et al (1982) publish a photograph which shows 4 beaked whales, possibly of this species. Gambell et al (1975) explain the difficulty in obtaining observations of this genus in general. No population estimates are possible, and interactions with fisheries are unlikely.

Mesoplodon densirostris Blainville's beaked whale
Widely distributed throughout the world, and recorded from the Seychelles (Hershkovitz 1966), this species is still rarely seen, and no population estimates are possible. No interactions with fisheries are likely.

(Mesoplodon layardii Strap-toothed whale
Leatherwood and Reeves (1983) suggest the probable existence of this species in area 51, although there are apparently no records of it here. No interactions with fisheries can be foreseen).

Mesoplodon grayi Gray's beaked whale
Leatherwood and Reeves (1983) state that sighting frequency suggest that this species may be common south and east of Madagascar in deep water. Keller et al (1982) suggest a further possible sighting in the Seychelles. No population estimates are available. No interactions with fisheries are likely.

Mesoplodon ginkgodens Ginkgo-toothed beaked whale
Recorded from this area only in Ceylon (Hershkovitz 1966). Again no interactions with fisheries are likely.

Ziphius cavirostris Cuvier's beaked whale
Sighted by Keller et al (1982) around the Seychelles, the distribution of this species is presumed to include all oceans. Pelagic and not commonly observed, no interactions with fisheries are foreseen at present.

Hyperoodon planifrons Southern bottlenose whale
A cold water species which, although generally presumed to inhabit the southern Indian Ocean, does not appear to have been sighted in area 51 (NCC 1980). No population estimates can be made for this area, and no interactions with fisheries are likely at present.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps show a patchy distribution of catches throughout area 51, right up to the southern Arabian coast. No current population estimates are available for area 51, but this could be in the hundreds of thousands. No interactions with fisheries would seem likely at present as very little squid is caught in this area.

Kogia breviceps Pygmy sperm whale
Marcuzzi and Pilleri (1971) include the west Indian Ocean in the distribution of this species. Records from Africa are even more scarce than from other areas (Handley 1966), so this species must be considered uncommon here, as elsewhere. No interactions with fisheries are predictable, as even the diet is unclear.

(Kogia simus Dwarf sperm whale
Generally presumed to inhabit all warm waters, records from the Indian Ocean are very sparse. No interactions in area 51 are likely.)

Steno bredanensis Rough-toothed dolphin
Reported from the Seychelles (Keller et al 1982) and from the Zambezi Coast and Aden district (Best 1971 cited in Keller et al 1982). The status is unclear, but this species is rarely recorded. There is no information on feeding in area 51, and there are no records of interactions with fisheries in this area either.

Sousa chinensis Indo-Pacific hump-backed dolphin
Recorded from Ceylon to the Suez Canal, to South Africa and in the central Indian Ocean (Marcuzzi and Pilleri 1971, NCC 1980). The number of records of this species might indicate that it is quite common in this area, but this may be because it frequents shallow coastal waters and is easily seen. There are a number of records of this speces being trapped accidentally in shark nets in Natal, and these are recorded in the South African Progress Reports to the IWC. Such mortalities may have considerable local impact on populations. The 1982 report suggests that these individuals may have been following a sardine run when they became trapped. Saayman and Tayler (1973) suggest that Sousa is a solitary species feeding on rocky outcrops and reefs near to the shore. There is no

data on food species, but for an inshore species such as this, which Mitchell (1975) states 'seems to feed on fish', it would seem likely that some commercial species are taken. Given the artisanal nature of much of the fisheries in this area, incidental catches are also likely to occur, especially if synthetic fibre gill nets are employed in this area. So far very little such catch has been reported: Mitchell (1975a), citing Al-Robaae (1970) gives one example of a fisherman catching one specimen in the Arabian Gulf, Howell and Pearson (1977) record 4 more such events and Jones (1976) records Sotalia fluviatilis, presumably this species, in Indian coastal fisheries.

Peponocephala electra Melon-headed whale
The status of the population is unknown. The diet in this area is also unknown, and so nothing may be said about biological interactions with fisheries. There are no indications of operational interactions either.

Feresa attenuata Pygmy killer whale
There appears to be only one record of this species in area 51, that of Racey and Nicoll, cited in Keller et al (1982), in the Seychelles. It is very rarely recorded worldwide, which may imply that this is a rare species. The diet in area 51 is not known and there have been no records of interactions with fisheries in this area.

Psuedorca crassidens False killer whale
Keller et al (1982) do not record this species from the Seychelles, but Hershkovitz (1966) records it from Ceylon, Gambell et al (1975) from the Natal coast and Frazier (1983) from Zanzibar. The status of this species is unknown in this area and the diet is not clear anywhere but may include squid and fish. Mitchell (1975) states that this species damages fish on longlines worldwide, but there are no obvious records of this in area 51. Other interactions with fisheries are not predictable.

Orcinus orca Killer whale
Keller et al (1982) recorded this species in the waters around the Seychelles, and Gambell et al (1975) also record it in area 51, southeast of Madagascar. The killer whale does not appear to be particularly rare in any of the world's seas, but there are no population estimates for the Indian Ocean. The food may include other cetaceans (IWC 1982 SC/33/Rep 4) but there has been little published information. Elsewhere the diet is known to include fish, and Sivasubramanian (1964) states that in the period 1955 to 1963 Orcinus presence during tuna longlining operations in the Indian Ocean increased from 4% to 9.6%, in parallel to the increase in fishing. He suggests that around 4% of the catch may be lost to killer whales and sharks, adding that the crews state killer whale presence may increase or depress catch rates, depending on whether the fish are frightened onto or off the bait. He also states that Orcinus is widely distributed throughout the Indian Ocean. There does not appear to be any more recent information on this interaction however.

Globicephala macrorhynchus Short-finned pilot whale
Keller et al (1982) record a pilot whale from the Seychelles, and Leatherwood and Reeves (1983) state that it probably occurs in most of the warm waters of the Indian Ocean. There are no indications of abundance, but this species does not appear to be rare. Jones (1976a) summarises information on this species in the Indian Ocean. The diet is unknown, but if squid is important, then interactions with fisheries are likely to be small.

(Lagenorhyncus cruciger Hourglass dolphin
Although not yet recorded in this area, it is found in other southern oceans, where it may be quite common. There would not seem to be much chance for interactions with fisheries at present.)

Lagenodelphis hosei Fraser's dolphin
Perrin et al (1973) suggest a continuous high seas distribution throughout the area. Gambell et al (1975) report sighting this species regularly off the Natal coast; its status is unclear. There are no data on feeding, and no interactions with fisheries yet recorded in this area, although incidental catches in pelagic fisheries have occurred elsewhere.

Tursiops truncatus Bottlenose dolphin
No population estimates are available, but Mitchell (1975a) refers to it as abundant in temperate and tropical inshore waters. There is little published information on diet in this area, but this species is known to get caught in shark nets off Natal, where some have been drowned, apparently following sardine shoals (IWC 1982). At least 13 were killed in this way in 1981. The effect of this on the population is unknown. Mitchell (1975a) states that off Ceylon this species is regarded as vermin as it damages gill nets and catch, and that some animals are killed in beach seines. Jones (1976a) adds that Tursiops is also taken occasionally in Indian coastal fisheries. Presumably similar problems exist in other parts of this area, but data are lacking.

Grampus griseus Risso's dolphin
Gambell et al (1975) report sighting this species in the south of area 51, and Keller et al (1982) give details of other sightings around the Seychelles, and in the Red Sea. This species is widespread but not particularly abundant anywhere in its range. No interactions with fisheries are known or likely without an expanded squid fishery.

Stenella longirostris Spinner dolphin
Hershkovitz (1966) records this species from Ceylon; Leatherwood et al (1983) report spinning dolphins from the Seychelles, and Howell and Pearson (1977) record the species from Tanzania. There is no indication of its rarity except that Keller et al (1982) did not observe any during their survey around the Seychelles. Records of interactions with fisheries are limited to that of Howell and Pearson, who record a possible incidental capture in Tanzania. Jones (1976) who records this species occasionally in the Indian coastal fisheries, and Leatherwood et al (1983) who state that fishermen take tuna from under 'spinning dolphins' around the Seychelles. The association with tuna raises the potential problem of incidental captures, but as yet there are no reports of dolphin mortality associated with tuna seining.

Stenella coeruleoalba Striped dolphin
Rice and Scheffer (1968) describe this species as widely distributed in temperate and tropical waters around the world. Gambell et al (1975) report hundreds of this species from waters around Madagascar and Watson (1981) reports seeing large schools east of the Seychelles. There is no other information relating to population sizes or feeding in this area, so the potential for interaction with fisheries is unclear.

Stenella attenuata Spotted dolphin
Rice and Scheffer (1968) report this species from the Indian Ocean, chiefly near coastal areas or islands. Keller et al (1982) tentatively describe spotted dolphins from the Seychelles, and Gambell et al (1975) describe them from the waters around Madagascar. There is no information on abundance and interactions with fisheries. Presumably a potential exists for incidental capture in purse seining operations, but this has not been reported yet.

Delphinus delphis Common dolphin
Leatherwood and Reeves (1983) describe this species as very widely distributed, occurring in all temperate and tropical seas, including the Indian Ocean. Jones (1976) describes this as one of the more common species in the seas around India, but Keller et al (1982) do not record it from the Seychelles. Jones (1976) describes fishing operations in Indian coastal waters, which include shore seines, boat seines, drift nets and fixed gill nets fishing for mackerel, sardines, anchovies and black tuna. Common dolphins are said to be caught in such nets often. The South African Progress Report to the IWC also reports a number of common dolphins trapped in shark nets off Natal. In 1981, at least 89 were trapped, apparently having followed sardine shoals into the nets. It would seem likely that this species is frequently caught as a by-catch throughout the area. The diet is elsewhere known to include commercial species especially anchovies and sardines, and so some degree of 'biological interaction' would seem likely.

(Lissodelphis peronii Southern right whale dolphin
Rice and Sheffer (1968) describe the distribution of this species as in 'temperate' waters of the Southern Ocean, but there do not appear to be any clear records of it occurring in area 51, neither is this species recorded by Gambell et al (1975) in their survey of the waters south of Madagascar. Its existence in this area is therefore

uncertain and interactions with fisheries improbable).

(Phocoena dioptrica Spectacled porpoise
There is one possible sighting of this species from this area, (Frost and Best 1976). No other information is available on population status, feeding, or interactions with fisheries and the occurrence of the species in this are must remain questionable).

Neophocaena phocaenoides Finless porpoise
Hershkovitz (1966) gives the distribution as from South Africa to Japan, but Leatherwood and Reeves (1983) state that this porpoise occurs only in coastal waters of Pakistan and the Indian subcontinent in this area. Jones (1976) refers to this species as one of the most common in the seas around India, and states that it is often caught in inshore fishing operations. Leatherwood and Reeves (1983) also state that the diet includes prawns and shrimps, cephalopods, and small fish. Recorded interactions with fisheries in this area are confined to a by-catch in Indian inshore waters, which Jones (1976) suggests involves large numbers. The effect on the population is unknown.

Platanista minor Indus susu
Jones (1976) states that this species is caught in seines and other multipurpose nets in the Indus river system. The population is critically low, but the extent to which this situation is due to interactions with fisheries is unknown.

Artocephalus tropicalis Subantarctic fur seal
The fur seal breeds on isolated subantarctic islands, occasionally wandering to South Africa. Food is thought mainly to be squid (Rand 1956), and no interaction would seem likely with fisheries at present.

Dugong dugon Dugong
At present rare throughout this area, the dugong is nevertheless still apparently caught incidentally in fishing nets on the Kenyan coast (Martin 1981), and in Ceylon (Bertram and Bertram 1970); this may represent an important source of mortality. Few data are published, but for a coastal species such as this, by-catches probably occur throughout its range in significant numbers.

At least 39 species of marine mammals are known to inhabit the waters of area 51, although information on species distribution is very poor for the Indian Ocean as a whole. The area has been declared a cetacean sanctuary by the IWC (IWC 1980) whereby commercial exploitation of cetaceans is prohibited.

At least 10 of the species occurring in this area are thought to be wholly or partly squid eating. There are also 8 baleen whale species, only one of which is known to feed on fish in this area. It has been suggested that there may be year round population of certain species of baleen whales in the tropical Indian Ocean. If so these may also feed on fish. Of the remaining cetacean species, 7 or 8 are known or thought to eat commercial fish or shrimp species. The remaining species are too poorly known to comment on.

The interactions listed above include at least 9 species which are involved in operational interaction and one, Tursiops, which has been accused of damaging fish stocks. It seems probable that given the lack of information on most of the species and the nature of most of the fisheries in the area, there are many more operational types of interactions than are recorded.

THE FISH STOCKS OF AREA 51

DEMERSAL FISH RESOURCES

The shelf area in the Indian Ocean is comparatively small (Gulland 1983), which means that demersal catches are limited. Furthermore, trawling is not so important a fishing method here as it is elsewhere. The FAO Atlas of Living Marine Resources (FAO 1981) suggests a total potential yield in area 51 of around 2 million tonnes, whereas the demersal catch in 1981 was less than 0.5 million tonnes. According to Gulland (1983) most of the fisheries around India are artisanal, with some trawling for shrimps, which

produce by-catches of other species.

Harapadon nehereus Bombay duck
Providing the largest demersal catches in this region, in 1980 115 000 tonnes were taken, mostly by Indian fisheries.

Sciaenidae Drums and Croakers
The second largest catch record is for miscellaneous Sciaenids, which amounted to 113 000 tonnes in 1980. This family is distributed throughout the region especially in warmer waters, there are no overall estimates of potential, nor is the state of the stocks known.

The catch statistics (FAO 1983) list very few species in the demersal fish catch, most catches being lumped either into families, or else into larger groups. The 3rd largest catch records are of 'demersal percomorphs not elsewhere included', which amounted to 55 000 tonnes in 1980.

Other fish caught include the usual assemblage of tropical families, Serranidae, Lutjanidae, Sparidae, Lethrinidae, Pomadasyidae and Leiognathidae. There is very little published on the state of the stocks of these species, but Gulland (1983) notes that some local stocks such as those around Mauritius and on east African reefs are heavily fished, whereas in other areas such as the Gulfs, are still under exploited.

There is little data on marine mammal feeding on demersal fish in this area, but Tursiops, Sousa and possibly Delphinus and Neophocaena are all possible predators of demersal fish, in that they all frequent coastal zones.

PELAGIC FISH RESOURCES

The FAO Atlas of Living Marine Resources (FAO 1981) provides an estimate of total potential pelagic resources of the Indian Ocean as around 4.6 million tonnes, at least 2 million tonnes of which are distributed in the western half. The largest fishery is the Indian oil sardine fishery.

Sardinella longiceps Indian oil sardine
Dense concentrations of this species exist on the south and west coasts of India, and were, until recently, fished for almost exclusively by traditional methods, especially beach seines (Gulland 1983). These nets are known to capture a number of small cetaceans, in particular the common dolphin, bottlenose dolphin, spinner dolphin, finless porpoise and Indo-Pacific hump-backed dolphin (Jones 1976). There are no statistics collected for by-catch of small cetacea, but Jones gives one example of 17 finless porpoises being landed in one haul. It may be that this by-catch has a significant effect on the population of at least one species. In 1980 210 000 tonnes of oil sardines were landed, including an increasing proportion of catches taken by small purse seiners. Gulland (1983) suggests that the potential for small pelagic fish catches on the Indian coast is much greater, but that the lack of more modern fishing methods means that much of the resource remains unexploited, offshore. Presumably this provides a number of marine mammals with an adequate food supply.

Tunas
A number of tuna species are taken, and this is one of the few fisheries in the Indian Ocean on which foreign fleets operate. Korean and Japanese boats both take a few tens of thousands of tonnes of tuna from this area, using longlines. At least two species, the killer whale and false killer whale are both known to take fish from tuna longlines, and specific examples are known of Orcinus conflicting with fishermen in this area in this way. There are no obvious records of such a type involving Pseudorca in this area, but Mitchell (1975a) states that they occur worldwide.

Until 1983 there was very little of the large scale tuna seining operations as seen in the Pacific, but several vessels operated in 1983, and perhaps two dozen are expected to operate in 1984 (Gulland, pers. comm.). There is evidence that Stenella schools over tuna in this area, and so there is an obvious risk of mortality to these species which

could result from the development of the tuna fishery (Gulland, pers. comm.).

The total catch of tuna species in the area in 1980 was under 100 000 tonnes; the potential for the entire Indian Ocean has been put at 600 000 tonnes. The proportion of this which might be expected in the western half is not stated.

Other important pelagic species include other clupeoids, 'pelagic percomorphs', amberjacks and some mackerel species. Bryde's whale has been noted by Leatherwood et al (1983) as a probable predator on shoals of mackerel which yield around 50 000 tonnes throughout the area.

There are also, according to Gulland (1983) other underexploited stocks of sardines in the Gulf regions, which at present are uneconomic to fish.

INVERTEBRATE RESOURCES

CRUSTACEA

Shrimp trawling is known throughout most of the area and is an important fishery economically. Over 250 000 tonnes of Natantian decapods were taken in 1980. Again the most productive areas appear to be around India and Pakistan, where traditional fishing methods are employed alongside trawlers. Gulland (1983) argues that the stocks of shrimp in both the Indian region and in the Gulf are currently overexploited. Only one species of marine mammal, the finless porpoise, is known to feed on shrimps. The effect of the exploitation of shrimp stocks in the area on the population of Neophocaena is unknown.

CEPHALOPODS

The cephalopod fisheries of this area took around 17 000 tonnes in 1980. Voss (1973) has found that there is very little information on cephalopod resources in this area, and cites Gulland (1971) for a rough estimate of several hundred thousand tonnes in coastal waters. Clearly here as in most other areas, cephalopods represent a vastly underutilised resource. There are at least 10 partly or wholly squid-eating cetacean species in this area, for none of which is there a reliable population estimate. The total predatory biomass on squid must be at least several hundred thousand.

THE FISHERIES OF AREA 51

Gulland (1983) provides a brief summary. Most fishing in this area seems to be small scale, although locally based small trawlers and purse seiners operate in several parts, especially off India. Foreign boats are very few and take less than 4% of the total catch. Longliners are and now some purse seiners take tuna, and some trawling occurs in the Arabian Sea.

Local fishing methods include handlining and trapping on reefs, and gill nets almost everywhere. Jones (1976) has included a brief description of some types of Indian fishing, which include 600 m "rampani" and other beach seine nets, small boat seines and fixed gill nets. Many of these are presumed to take coastal marine mammal species as a by-catch.

The major fishing nations of the area are India, with catches of over a million tonnes and Pakistan and Sri Lanka with catches of a few hundred thousand tonnes each. A few other countries also take tens of thousands of tonnes a year, but in general the reported catches are small when compared with other areas.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 51

Operational interactions

These may be split into 2 categories

1 By-catches of a number of species occur, apparently throughout the region, but are seldom reported. In South Africa Sousa chinensis, Tursiops truncatus and Delphinus delphis are taken in shark nets off Natal. In the waters around India a number of species, notably Neophocaena phocaenoides and Delphinus delphis are taken in a variety of gears particularly shore-based seine nets. There are some other scattered reports of marine mammal capture in gill and seine nets, including Dugong dugon, the population of which may be under pressure from such mortalities.

2 Other operational interactions include harassment of tuna longliners by killer whales and, possibly, the false killer whale, Pseudorca crassidens. Dolphins of the genus Stenella are known to associate with tuna in the area; although this has led to little if any mortality so far, the development of a purse-seine fishery makes future by-catches more likely.

Biological interactions

Here as elsewhere, biological interactions with fisheries remain obscure. Certain species, notably Balaenoptera edeni, Delphinus delphis and Tursiops truncatus almost certainly prey on commercial fish stocks. Neophocaena phocaenoides feeds largely on shrimps in coastal waters, which may be overexploited. Large amounts of squid are currently consumed by a number of marine mammal species, but at the moment scarcely any cephalopods are fished for in this region. Dolphins of the genus Stenella are known in other areas to feed on small mesopelagic fish. It is interesting at this point therefore to note that Gulland (1983) has suggested that mesopelagic fish form a large part of the fish biomass between Somalia and Pakistan. At present these stocks are unexploited, largely for technical reasons.

3.10 AREA 57: EASTERN INDIAN OCEAN

MARINE MAMMALS FOUND IN AREA 57

Eubalaena glacialis Right whale
Hershkovitz (1966) states that the right whale occurs as far north as 30°S in the western Indian Ocean. Breeding sites exist along the south and western coasts of Australia, but the population is at present severely depleted. There are no population estimates, but in 1981 42 animals were sighted off Australia during aerial surveys (IWC SC/34/Prog Rep Australia 1983). The Report of the Workshop on the Status of Right Whales (IWC SC/35 Rep. 2 1983) notes one individual which was caught in a shark net in South Australia in 1982, but does not state whether the animal died or was released. If death by entanglement in netting does occur, even a few deaths could be significant to such a small population.

Caperea marginata Pygmy right whale
Marcuzzi and Pilleri (1971) note that the maximum density is observed around southern Australia and New Zealand, and Ross et al (1975) state that the most northerly point from which this species is known is 30°S on the west Australian coast. No interactions with fisheries are known, and there are no population estimates either.

Balaenoptera physalus Fin whale
Known to occur throughout the area, although Tomilin (1967) states that it is rare in the tropics. There are no reliable population estimates in this area, and no recorded interactions with fisheries. The diet is not known to include any fish in southern oceans (Nemoto 1959).

Balaenoptera musculus Blue whale
Known from all seas (Tomilin 1967), there are no population estimates in this area, but

the population could number in the thousands. No interactions with fisheries are known. The diet does not include commercial species.

Balaenoptera acutorostrata Minke whale
Rice and Scheffer (1968) state that the minke whale is rare in tropical waters but widely distributed in all oceans. The diet in warmer waters is unknown, if indeed there is any feeding at lower latitudes. The population in area IV of the Antarctic, which corresponds roughly with FAO's area 57 in latitude, has been estimated at just under 100 000 (IWC 1983 p 94)

Balaenoptera borealis Sei whale
Found in all oceans (Rice and Sheffer 1968). The sei whale population in area 57 is unknown but may be presumed to be similar to that of Antarctic area IV, between 10 and 20 000. There are no records of this species consuming commercial species in area 57 and interactions with commercial fisheries seem unlikely.

Balaenoptera edeni Bryde's whale
Ivashin (1980) records this species from Western Australia, India and Malacca; presumably it occurs throughout area 57. There do not appear to be any population estimates or published information on the diet of this species in area 57. Commercial fish are consumed elsewhere, and so presumably may be here as well. There are no apparent records of interactions with fisheries here either.

Megaptera novaeangliae Humpback whale
Breeding grounds exist off the western coast of Australia, to which humpbacks migrate from Antarctic waters (Marcuzzi and Pilleri 1971). The population size is unknown but probably numbers in the hundreds. There does not appear to be any evidence of feeding outside the Antarctic in this area, and no obvious interactions with fisheries either.

Berardius arnuxii Arnoux's beaked whale
Mitchell (1975) describes this species from South Australia. Nothing is known of the population size, nor the diet in this area, although this presumably consists of squid.

(Mesoplodon pacificus Longman's beaked whale
One specimen is recorded from Queensland in Australia (Rice and Sheffer 1968) and another from Somalia; if the distribution is continuous this species might be expected to inhabit area 57 also. The diet is presumably squid, and the population size unknown.)

Mesoplodon densirostris Blainville's beaked whale
Rice and Scheffer (1968) state that this species is distributed in tropical and warm temperate waters of all oceans. Leatherwood and Reeves (1983) record it from Tasmania and the Nicobar Islands. No interactions with fisheries seem likely at present.

Mesoplodon layardii Strap-toothed whale
Leatherwood and Reeves (1983) state that this species has been found in southeastern Australia and Tasmania. There is no information on the population size.

Mesoplodon hectori Hector's beaked whale
Recorded from Tasmania (Rice and Scheffer 1968) in area 57, a circumpolar distribution in temperate waters is suggested. There is no information on population size.

Mesoplodon grayi Gray's beaked whale
Recorded from South Australia (Leatherwood and Reeves 1983) this appears to be another species with a circumpolar distribution in southerly waters.

Mesoplodon bowdoini Andrew's beaked whale
Rice and Scheffer (1968) state that this species has been recorded from Tasmania and Western Australia. The distribution in the rest of area 57 is therefore conjectural.

(Mesoplodon ginkgodens Ginkgo-toothed beaked whale
Recorded from Japan and Ceylon (Rice and Scheffer 1968), if the population is continuous, then area 57 should also be included in the distribution of this species.)

Ziphius cavirostris Cuvier's beaked whale
Found in all temperate and tropical seas, as with all other beaked whales, there are no population estimates, and the food is presumed to be squid.

Hyperoodon planifrons Southern bottlenose whale
Known from Australia and off Antarctica in the Indian Ocean sector (Rice and Scheffer 1968), Mitchell (1975) describes it as widespread in all southern oceans. No abundance estimates are available. The food is thought to be squid (Mitchell 1975), and there are no apparent conflicts with fisheries.

Physeter macrocephalus Sperm whale
Townsend's (1935) charts show dense catching grounds off Western Australia. The population is currently recovering after the cessation of Australian sperm whaling in the late 1970's, which operated from Albany in Western Australia. The population size is unknown, but could number in the hundreds of thousands for the whole of area 57.

Kogia breviceps Pygmy sperm whale
Leatherwood and Reeves (1983) state that this species has been found in southeast Australia, implying that it does occur in area 57; they suggest that it is found in all temperate warm waters of the world. There is no population estimate, but this does not appear to be a common species. There are no data on feeding in area 57 either, and no apparent interactions with fisheries.

Kogia simus Dwarf sperm whale
Known from strandings in South Australia, Sri Lanka and India (Leatherwood and Reeves 1983) the distribution is assumed to cover most of area 57. No population estimates are available and there are no apparent interactions with fisheries in this area.

Steno bredanensis Rough-toothed dolphin
Leatherwood and Reeves (1983) state that this oceanic dolphin has been recorded from much of Indo-Australian archipelago. There are no indications of abundance, nor of any interactions with fisheries reported.

Sousa chinensis Indo-Pacific hump-backed dolphin
Leatherwood et al (1983) were told in Penang that this species was found in the waters thereabouts, and Leatherwood and Reeves (1983) reports hump-backed dolphins from India to the middle of the west coast of Australia. There do not appear to be any estimates of population abundance or of feeding in this area, but Jones (1976) states that this species is taken in coastal fisheries in India and Bangladesh.

Orcaella brevirostris Irrawaddy dolphin
Hershkovitz (1966) describes the distribution in coastal and estuarine waters from the Bay of Bengal to northern Australia, and in several river systems. There do not appear to be any indications of abundance, though Watson (1981) states that it is still fairly common everywhere. U Tin Thein (1977) describes how this species helps local river fishermen by herding fish into their nets. Leatherwood et al (1983) were informed by local fishermen on the Irrawaddy river that the dolphin eats catfish.

Peponocephala electra Melon-headed whale
Leatherwood and Reeves (1983) describe this species as having a worldwide distribution in tropical and subtropical seas. There do not appear to be any data relating to abundance, feeding, or interactions with fishermen in this area.

(Feresa attenuata Pygmy killer whale
Rarely recorded worldwide, there do not appear to be any records of this species in area 57, but its presence is inferred by Mitchell (1975) and other authors.)

Psuedorca crassidens False killer whale
Distributed in tropical and warm temperate waters, normally offshore (Mitchell 1975); Harwood et al (1983) provide one of the few records of this species. They state that 1 was recovered from Taiwanese gill nets, fishing for sharks, tuna and mackerel, in northern Australian waters, but it is not clear whether this was in area 57 or 71. This species is also said to damage tuna on longlines worldwide (Mitchell 1975a). There does

not appear to be any other information regarding interactions with fisheries, abundance, or feeding habits in this area.

Orcinus orca Killer whale
Found in all seas (Hershkovitz 1966), Leatherwood et al (1983) report the probable sighting of an individual north of the Andaman Islands, and there are numerous accounts of the species off southwestern Australia. Reports of interactions with fisheries include the account of Sivasubramanian (1964) who states that killer whales are often found around tuna longlining boats, where they damage up to 4% of the catch and may scare fish away from, or onto, the hooks. Other accounts of interactions in this area relate to the Australian whaling industry at Twofold Bay, where several killer whales were in the habit of helping whalers, apparently by alerting them to the presence of humpback whales and aiding in their capture. The killer whales were rewarded with whale meat. Killer whales are also known to take up to 30% of hooked fish in a dropline fishery off the east coast of Tasmania (IWC 1981 annexe H). There are few other published records of killer whales in this area, so their abundance and diet are unclear.

Globicephala melaena Long-finned pilot whale
This species is recorded from all temperate southern seas (Leatherwood and Reeves 1983). There do not appear to be any abundance estimates, feeding data or recorded interactions with fisheries.

Globicephala macrorhynchus Short-finned pilot whale
Jones (1976a) provides a summary of information on this species in the tropical and subtropical Indian Ocean, stating that it does not occur in Indian coastal waters. There seem to be no abundance estimates, feeding data or records of interactions with fisheries in this area.

Lagenorhynchus obscurus Dusky dolphin
Rice and Scheffer (1968) describe this as a coastal species, found in southern Australia. There do not appear to be any published accounts of its abundance or feeding habits in this area, nor any accounts of interactions with fisheries.

(Lagenorhynchus cruciger Hourglass dolphin
Brownell (1974) describes the distribution of this species as pelagic and circumpolar in the southern hemisphere, but it does not appear to have yet been recorded in the southern Indian Ocean.)

(Lagenodelphis hosei Fraser's dolphin
Perrin et al (1973a) suggest a continuous distribution in the tropical high seas of the Indian and Pacific Oceans, but there do not appear to be any records from area 57, although its presence is presumed).

Tursiops truncatus Bottlenose dolphin
Leatherwood and Reeves (1983) describe the distribution of the bottlenose dolphin throughout the Indian Ocean from Australia to South Africa. Jones (1976) describes this as one of the species which is caught accidentally in the coastal waters of India and Bangladesh by artisanal fisheries. Harwood et al (1983) also note that this species is one of the most frequently caught in Taiwanese gill net fisheries off northern Australia; some of these catches are apparently made in area 57. There seem to be no published accounts of diet or abundance for this area. As in other areas, interactions with fisheries are likely throughout the area, even though not reported.

Grampus griseus Risso's dolphin
Recorded from all tropical and temperate seas (Mitchell 1975). Leatherwood et al (1983) provide a record from the Bay of Bengal. There do not appear to be any abundance estimates nor accounts of interactions with fisheries. The diet is presumed to be mostly squid.

Stenella longirostris Spinner dolphin
Mitchell (1975) records this species from Australia, Ceylon and Indonesia. Jones (1976) records it as one of the coastal species caught in local fisheries around the coast of India and Bangladesh, but there are no data on this by-catch, nor on abundance or feeding

in the area. This species is known to associate with tuna around the Seychelles, and so may be vulnerable to dolphin associated tuna purse seining in this area also (see area 51). There seem to be few other records of this species in area 57.

Stenella coeruleoalba Striped dolphin
Rice and Scheffer (1968) state that this species is widely distributed in temperate and tropical waters around the world. Leatherwood et al (1983) record it in the western Indian Ocean, but not in area 57. The only other obvious record of this species in the area is that of Watson (1981) who reports seeing large schools "south of Java". No population estimates, data on feeding or reports of interactions with fisheries are available for this area.

Stenella attenuata Spotted dolphin
Spotted dolphins are apparently distributed throughout the warm waters of the Indian Ocean from the Maldives, south and east to New Zealand (Hershkovitz 1966, Leatherwood and Reeves 1983). Leatherwood et al (1983) report Stenella attenuata from the Bay of Bengal, but there appear to be no reports of interactions with fisheries, nor any published information relating to abundance or feeding for area 57.

Delphinus delphis Common dolphin
Described by Jones (1976) as one of the commonest species in coastal waters around India and Bangladesh. Leatherwood et al (1983) record this species in the Bay of Bengal; Rice and Scheffer (1968) describe this species as widely distributed in all warm temperate and tropical ocean areas. There do not appear to be any abundance estimates or data on feeding for this area. Jones (1976) provides the only report of interactions with fisheries, reporting that many are taken as a by-catch in Indian coastal fisheries. Other interactions would seem likely elsewhere in area 57, but are not reported.

Lissodelphis peronii Southern right whale dolphin
Distributed around the southern hemisphere in cold waters (Brownell 1974) there are no records of interactions with fisheries in this area and none seem likely at present.

Neophocaena phocaenoides Finless porpoise
One of Jones' (1976) two most common species of coastal marine mammal, and one which he states is frequently caught in beach seines and other artisanal fishing gear along the Indian coasts. Mitchell (1975) records this species from throughout southeast Asia.

Interactions between fisheries and this species would seem to be very likely due to its neritic habitat but are not reported. Elsewhere the diet is said to consist largely of shrimps, which are commercially fished for in this area.

Platanista gangetica Ganges susu
The population has been estimated at around 4 - 5 000 (Jones 1982). Mitchell (1975) states that this species occurs with commercial fish species and that fishermen set their nets around dolphins. Small numbers are said to be taken in seine nets. Jones (1982) describes accidental drownings of susu in drag nets and seine nets, which he states are not uncommon. Jones also states that the susu's food is mainly catfish, prawns and other bottom living animals. The by-catch does not seem to be having too dramatic an effect on the population at least below Farakka and in the entire Brahmaputra-Meghna complex of rivers in India and Bangladesh, where Jones (1982) states "there are no signs of depletion in susu population".

Neophoca cinerea Australian sea lion
Confined to area 57, around the south coast of Australia. Walker and Ling (1981a) suggest that this species was almost wiped out by commercial sealing in the last century, and that its range is less extensive than previously. Warneke (1982) has estimated the population at between 3 - 5 000. Little is known of the diet but this may include fish, squid and penguins. Storr (cited in Walker and Ling 1981a) reports this species feeding on salmon (Aripis trutta) and causing damage to nets whilst doing so. And Warneke (1982) also states that salmon fishermen dislike the sea lion as it attacks their nets to get at fish. Walker and Ling (1981a) report this species taking whiting (Sillaginodes sp.) from the nets of fishermen on Kangaroo Island, and similar occurrences wth shark fishermen. They add that the sea lion has been observed to take crayfish and lobsters too. Warneke

(1982) suggests that there is no widespread complaint against this species by the fishing industry, probably because it does not occur in large numbers in any one place.

Artocephalus pursillus doriferus Australian fur seal
Warneke (1982) estimates the population size at around 20 000 animals, two thirds of which breed in Bass Strait. The diet is predominantly cephalopod, including Notodarus, Sepioteuthis, Sepia and Octopus, but fish are also eaten (Warneke 1982). Warneke also refers to recoveries of drowned seals from traps and trawl nets, so there is evidently some by-catch of this species in the local fisheries, but this has not been quantified. He continues that fishermen widely maintain that this species damages fish stocks, but that such claims are not substantiated by data on feeding. The Australian fur seal does pose a problem to sedentary mesh net fisheries in Port Philip and Western Port Bays in Victoria, which are near to a large breeding colony. Individual seals can do extensive damage to nets and catch, which Warneke states is only effectively remedied by the prompt destruction of the offending seal.

Arctocephalus forsteri New Zealand fur seal
Crawley and Warneke (1979) have described the distribution of this species in southern Australia; which population Warneke (1982) suggests may not exceed a few thousand individuals. He adds that the diet in Australian waters is unknown. By comparison with the diet in New Zealand, cephalopods and barracouta might be presumed to be important. Warneke (1982) also suggests that this species does not occur in sufficient numbers to be considered a problem by fishermen in Australia, but Crawley and Warneke (1979) suggest there may be some incidental losses through drowning in net and rock lobster fisheries.

Mirounga leonina Southern elephant seal
Marlow (1967) states that in former times this species occurred in large numbers on King Island and Tasmania, but that after the disappearance of these colonies only occasional stragglers appear. The diet is known to include fish and squid, but as the population in this area is apparently so small, there are unlikely to be any significant interactions with fisheries.

Hydrurga leptonyx Leopard seal
During spring some stragglers appear on Australian beaches, normally young animals (Marlow 1967). Feeding is not known to include any commercial fish species and interactions with fisheries in area 57 seem unlikely.

Leptonychotes weddelli Weddell seal
Another Antarctic species, the Weddell seal has been recorded once on an Australian beach (Marlow 1967) but presumably feeds in the southerly waters of area 57. There are no published records of interactions with fisheries but these might be possible if Antarctic fish are to be harvested in any quantity.

Dugong dugon Dugong
Known to occur in area 57 from the Indian subcontinent to North and Western Australia (Bertram and Bertram 1973). Described as rare throughout much of its range (FAO 1978) there are no data on incidental captures, but these are thought to be one of the major reasons for the population decline (FAO 1978).

The amount of published information on marine mammals in area 57 is very small, with the exception of some Australian species, notably the pinnipeds. About 49 species of marine mammal are thought to occur in this area, and for most of these almost nothing is known about their abundance or feeding habits in the area.

There are 8 species of baleen whale, 7 of which feed mostly in Antarctic waters on pelagic crustacea. There have been some suggestions, however, that some species such as the humpback and minke whales may be present all year in the Indian Ocean, and this prompts the question of what they eat. Certainly Bryde's whales feed in tropical and subtropical waters, and it is assumed that commercial species are eaten. It is possible that other baleen whale species also feed on fish in this area.

There are possibly 10 species of beaked whale known to occur in the area all of which might be presumed to feed on squid.

Of the remaining 24 cetacean species, the diets of most are unknown. Susu are known to eat catfish and other bottom dwelling organisms, and catfish are also thought to be in the diet of Irrawaddy dolphins. Finless porpoises eat shrimps, and in view of killer whale harassment of tuna longlines, these may consume some tuna. For the rest, it could be assumed that some species such as the bottlenose and common dolphins eat some commercial species of fish.

The diets of the pinnipeds by comparison, are very well known. Squid is the major food item with a number of commercial fish species also taken to a much smaller extent.

THE FISH STOCKS OF AREA 57

DEMERSAL FISH RESOURCES

The magnitude of the demersal resources in this area is not well known, recent estimates being in the range of 2-3 million tonnes. The statistics for a number of countries are incomplete, and there is little information on species composition. Of the listed groups of fish in the FAO Fisheries Statistics Yearbooks, only 4 have recorded catches of more than 10 000 tonnes. The total catch of demersal species is probably a little over half a million tonnes (FAO 1981a).

These are Leiognathids (33 000 tonnes), Sciaenids (20 000), sea catfish (Ariidae: 22 000 tonnes) and other percoids (15 500 tonnes).

There are no records of interactions between demersal fisheries and marine mammals, and no indication of any feeding by marine mammals on demersal species apart from the Irrawaddy river dolphin which is thought to feed on catfish (Leatherwood et al 1983). The state of most of the stocks is unknown, although it is believed that the inshore stocks along the densely inhabited coastlines of South and Southeast Asia are heavily exploited.

PELAGIC FISH RESOURCES

The total potential of pelagic fisheries in the eastern half of the Indian Ocean is unknown, but exceeds 800 000 tonnes. The total recorded catch of pelagic species in 1981 was 371 000 tonnes, but again, there were 780 000 tonnes of miscellaneous marine fish also caught, which presumably increases the true pelagic catch. The state of most of the stocks is unknown.

Sardinella longiceps

The Indian oil sardine dominates the list of identified species 75 000 tonnes having been reported in 1981. As with area 51, most of this seems to have been taken by artisanal methods such as beach seines, though purse seines are used in some areas.

Other species

Carangids, anchovies and mackerels are all important stocks in this area, and may all represent food species for a number of cetaceans, notably Bryde's, and possibly other baleen whales.

Tuna

Several species are taken, catches of all species exceeding 40 000 tonnes in 1981 (FAO 1983). Japanese and Korean catches of all species in area 57 totalled 15 000 tonnes in 1981 (FAO 1983), most or all of which was presumably tuna, as Gulland (1983) suggests this is about all that foreign fleets take in the area. Longlines are used extensively for catching tuna, but Harwood et al (1983) indicate that Taiwanese vessels take some tuna off northern Australia by gill nets. This fishery leads to extensive cetacean mortality, and the longlining fishery is known to come into conflict with killer whales (see above).

INVERTEBRATE RESOURCES

CRUSTACEA

Natantian decapods are possibly the most important fishery resource in the area. In Indonesia for example, the value of the banana prawn, udang putih (Penaeus merguiensis) was around Rp 54 000 million, individually identified species, more than twice the value (Rp 21 000 million) of the next most valuable tongkol (Euthynnus spp) (Indonesia Fishery Statistics 1981). Gulland (1983) suggests stocks of shrimps around India may be heavily fished. The interaction between such fisheries and cetaceans such as the finless porpoise, which feeds on shrimp, are unknown.

CEPHALOPODS

The total cephalopod catch in the area was less than 8 000 tonnes in 1981; Voss (1973) cites Gulland (1971) in suggesting that the potential for the whole Indian Ocean may be at least several hundred thousand tonnes.

THE FISHERIES OF AREA 57

Gulland (1983) summarises the fisheries of area 57. As with 51, the emphasis is heavily on small scale fisheries. In India these include beach seines, boat seines, gill nets and cast nets; similar gears are used off Sumatran and Javan coasts. Industrial scale fishing is developing, including trawling, especially for shrimp, and purse-seining.

Further south, off Australia, stocks of fin-fish are underexploited (FAO 1981a); the main fishery there appears to be for lobster and shrimp. Harwood et al (1983) describe Taiwanese gill netting operations on the northern coast, which extend into area 57. They estimate that thousands of small cetaceans, mostly Tursiops are killed in this fishery every year (4 500 from June 1981 to February 1983).

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 57

The extent of small scale fisheries in this area, coupled with the information that "there is increasing evidence ..... that many stocks are already heavily exploited" (FAO 1981a) in the more northerly regions, should indicate some considerable interaction with some of the 49 or so marine mammal species. Information on the subject, however, is sparse.

Operational interactions

1 Jones (1976) has stated that 5 species of small cetacean, the common dolphin, bottlenose and spinner dolphins, the Indo-Pacific hump-backed dolphin and the finless porpoise, are all caught in seine nets around the Indian subcontinent. These are all coastal species and are taken in coastal fisheries but there are no data on the numbers caught.

2 Harwood et al (1983) indicate that bottlenose dolphins, spotted and spinner dolphins, and at least one false killer whale have been taken in gill net fisheries off northern Australia. Their map indicates that some of these catches (4 out of 86) were taken in waters in area 57, the species involved here are not stated however.

3 Killer whales are known to harass tuna longliners in the Indian Ocean (Sivasubramanian 1964).

4 There is some conflict between fishermen and pinnipeds in southern Australia. Sea lions are known to damage nets and catch, as do some fur seals in fixed gill nets.

5 One right whale has been reported in a shark net off South Australia. (IWC SC/35/Rep 2, 1983).

6 Bannister (1977) states that a few small cetaceans are taken in Australian fisheries, without giving data for area 57. He reports that most kills are due to fishermen shooting dolphins because of their real or assumed interference with fishing operations.

7 Dugongs are known to be taken in nets throughout the area (FAO 1978). It would seem very likely that the reported cases of gear conflicts in this area represent only a small number of the total. The area is characterised in the northerly part at least, by intensive coastal fishing, and a relatively large number of coastal small cetaceans. The combination of these 2 factors seems likely to produce a great number of incidental captures of small cetaceans, particularly Sousa, Tursiops, Stenella spp, Orcaella, Neophocaena, Delphinus and Platanista.

8 The susu is taken in small numbers in the Ganges as a by-catch in seine nets (Jones 1982).

9 The Irrawaddy dolphin is said to help fishermen to catch fish by herding the fish into the nets (Tin Thein 1977).

Biological interactions

Fishermen in southern Australia are reported to claim that fur seals damage fish stocks (Warneke 1982), but such claims, it is suggested, are not borne out by analysis of the seals' diet.

The information being so sparse, there is little that can be surmised even concerning possible biological interactions. Certainly the presence of at least 10 species of squid eating cetaceans should be noted in the event that the greatly underexploited squid resources of this area are to be developed. The possible presence of year round baleen whale populations in tropical waters also poses interesting problems concerning the future expansion of either offshore pelagic fisheries, or of the baleen whale populations.

3.11 AREA 61: NORTHWEST PACIFIC

MARINE MAMMALS FOUND IN AREA 61

Eubalaena glacialis Right whale
The Report of the Right Whale Workshop (IWC SC/35/Rep2, 1983) suggests that this species was formerly distributed throughout this region. Berzin and Doroshenko (1982) cite Berzin and Yablakov (1978) in stating that the population is currently severely depleted, with probably only a few hundred animals left in the entire North Pacific. No interactions with fisheries are recorded.

Balaena mysticetus Bowhead whale
The population in the North Pacific is divided into two stocks. One moves from the Beaufort Sea to the Bering Sea and therefore partly into area 61, in winter; the other is confined to the Sea of Okhotsk (NCC 1980). The population of the former has been estimated at around 4 000 animals at present, and that of the latter 200-400 (Braham 1982). Interactions with fisheries would seem unlikely, although the possibility of net entanglement should not be ignored for this species or the previous one, as even a few mortalities could affect the population.

Eschrichtius robustus Grey whale
The Korean stock of this species may now be extinct, although the South Koreans are thought to have killed at least 67 between 1948 and 1966 (Wolman and Rice 1979). Feeding occurs, for both east and west Pacific stocks, in area 18 and food consists largely of amphipods (Blokhin and Pavlyuchkov 1983). No interactions with fisheries are likely at present, with the reservation that net entanglements are always possible.

Balaenoptera physalus Fin whale
Tomilin (1967) states that this species is found in the Sea of Japan and Sea of Okhotsk,

and as far south as Taiwan. Tomilin lists a great number of food species, and notes that whereas one North Pacific sample yielded stomach contents data indicating the diet was mostly crustacea, another sample taken during a 'herring run' contained mostly herring. Fish species listed in the diet include Clupea harengus, Mallotus villosus, Ammodytes personatus, Boreogadus saida, Theragra chalcogramma and a number of other species including cod and salmon. Despite the diet, there do not seem to be any records of interactions with fisheries. The population for the whole North Pacific has been estimated at between 14 and 19 000.

Balaenoptera musculus Blue whale
Wintering in the waters around Japan, Korea and Taiwan, the blue whale spends the summer around the Kurils, Kamchatka and Chukotka. The diet consists entirely of pelagic crustacea especially Thysanoessa inermis and Nematoscelis megalops (Tomilin 1967). The population size in the North Pacific has been estimated at between 1400 and 1900 (Berzin and Vladimirov 1981). There appear to be no recorded interactions with fisheries.

Balaenoptera acutorostrata Minke whale
The IWC recognises 2 stocks in area 61, the Sea of Japan - Yellow Sea - East China Sea stock, and the Okhotsk Sea - West Pacific stock. Block quotas for the periods 1980-1984 have been set by the IWC for catches of this species which total 5 312 for both stocks (IWC Annexe E 1983). The population size is not known, but may number in the tens of thousands. According to Tomilin (1967) this species eats walleye pollock, saffron cod, herring, capelin, sandlance and pelagic crustacea in the North Pacific. Clearly the diet indicates that there is some interaction with fisheries for food fish species. A few individuals have been reported in drift nets (2 in 1980) and fixed nets (1 in 1980) in Japan (IWC 1982: Prog. Rep. Japan).

Balaenoptera borealis Sei whale
Tomilin (1967) states that this whale is less well adapted to eating fish than minke or fin whales, and that although some fish are consumed, squid and crustaceans, especially Calanus are more important in the diet in the North Pacific. The population size has been estimated for the whole North Pacific at between 8 600 and 2 100 (Berzin and Vladimirov 1981). No interactions with fisheries are apparent, although if commercial species are included in the diet, then there may be an interaction to some extent.

Balaenoptera edeni Bryde's whale
Miyashita and Kasamatsu (1983) have presented a population estimate of the northwestern Pacific stock of this species to the IWC. They estimate a total population size of 4400; this estimate was not discussed at the 1983 IWC meeting due to lack of time. Omura (1966) has studied the diet of this species in the northwest Pacific, and concludes that this is mostly euphausiids. The distribution of the Bryde's whale extends as far as about 43°N, and although no interactions with fisheries have been reported, this species is also known to eat fish (Best 1967).

Megaptera novaeangliae Humpback whale
Tomilin (1967) states that this species migrates from Kamchatka and the Sea of Okhotsk to southern Japan, Bonin Island and the Mariana and Marshall Islands. There are insufficient data to estimate the population size, but only a few sightings from the northwest Pacific have been reported to the IWC in the last few years, so the population may number in the hundreds, and is clearly in a critical state. The diet of this species in the Soviet Far East has been described by Tomilin (1967) as partly similar to the fin whale, including herring, capelin, cod, salmon, sand eels, greenling, euphausiids and a variety of other shoaling crustacea. Although no recent interactions with fisheries have been recorded, probably due to the low population level, Tomilin describes an account by S K Klumov of 2 humpbacks causing trouble to fishermen by pursuing pink salmon off the Kuril Islands. A whaling boat was summoned, which killed one of the whales. Clearly the potential for conflict exists if the population ever increases again.

Berarduis bairdii Baird's beaked whale
Confined to the North Pacific (McCann 1975), 39 Baird's beaked whales were taken in the 1981/82 season by Japanese boats (IWC 1983: Prog Rep Japan). This species is known to feed on deep sea fish and squids including Gonatus fabricii and Onychoteuthis (Mitchell 1975); the status of the population is not known. There are no records in the Japanese

Progress Reports to the IWC of incidental captures of this species, and its diet would seem to preclude any other interactions with fisheries at present unless there is any competition for squid.

Mesoplodon densirostris Blainville's beaked whale
Watson (1981) records this species from Formosa, which may be the limit of its northerly distribution. There are no more detailed data, and interactions with fisheries seem unlikely.

Mesoplodon stejnegeri Stejneger's beaked whale
Only known from about 12 specimens, this species is thought to range from Honshu to the Bering Sea (Hershkovitz 1966). No interactions with fisheries are likely.

Mesoplodon bowdoini Andrew's beaked whale
The only record in this area of this otherwise southerly species is given by Nishiwaki (1962) from the Sea of Japan (Akita beach), interactions with fisheries seem unlikely on this basis alone.

Mesoplodon ginkgodens Ginko-toothed beaked whale
Recorded from Japan and Taiwan (Leatherwood and Reeves 1983), Watson (1981) also reports this species in at least 2 further, unconfirmed occasions on Japanese longlines near Taiwan. These seem to be the only records of Mesoplodon species interacting with fisheries. The implications are unclear, but it is possible that the captured animals may have taken the bait from the longline, if the bait was squid.

Mesoplodon carlhubbsi Hubb's beaked whale
Apparently restricted to waters off northwest Honshu (Leatherwood and Reeves 1983). There do not seem to be any interactions with fisheries.

Ziphius cavirostris Cuvier's beaked whale
This species has been caught in Japanese small whale fisheries in small numbers (Mitchell 1975) although there do not appear to be any records of such catches in recent years. Stomach contents analysed from the fishery indicate a diet of deepwater fish and of squid. There are no indications of the size of the population in area 61, and no apparent records of by-catches. Interactions with fisheries seem unlikely.

Physeter macrocephalus Sperm whale
Distributed throughout the area, chiefly south of 40°N, males may venture as far as the ice (Tomilin 1967). This species is still currently hunted by the Japanese in the North Pacific, with a catch quota of 890. There are no reliable estimates for the total population size in area 61, but this could be in the hundreds of thousands. Berzin (1972) summarises information on the diet of the sperm whale in this area, suggesting that the major part of this is squid. The type of squid eaten varies from author to author, but Gonatidae, Histioteutidae and Ommastrephidae all appear to be important families of squid in the sperm whale diet. Tomilin (1967) suggests that when fish do occur in the diet, these are chiefly elasmobranchs (see introductory section also). Interactions with fisheries would seem unlikely, except that Ommastrephid squids are an important part of the Japanese squid catches. The implications of this are unclear.

Kogia breviceps Pygmy sperm whale
Mitchell (1975a) states that this species is taken by chance with hand harpoons at the rate of 3 to 6 a year in southern Japan. Tomilin (1967) records this species from the Kuril Islands. The only records of interactions with fisheries seem to be Miyazaki's (1983) assertion that this species is taken sporadically in set nets or by other fisheries.

Kogia simus Dwarf sperm whale
Miyazaki (1983) suggests that this species is taken sporadically in some fisheries, but provides no data on this. The diet is probably mainly squid (Fitch and Brownell 1968).

Monodon monoceros Narwhal
The occurrence of this species in the Bering Sea is described as exceptional by Leatherwood and Reeves (1983). Tomilin (1967) states that the diet is mostly cephalopods, but

includes some fish such as skate, flounder, halibut, cod, salmon and herring, which presumably makes conflicts with fisheries possible, although there do not appear to be any records of such.

Delphinapterus leucas White whale
Tomilin (1967) describes this species as widespread in the coastal zone of cold waters, occurring as far south as the Sea of Japan. Gurevich (1980) has reviewed the diet. Interactions with fisheries do not seem to have been reported, although clearly a diet which includes salmon and other commercial species could lead to some conflict.

Steno bredanensis Rough-toothed dolphin
There is little data on this species in this area, except that Miyazaki (1983) records the capture of 23 of this species in a drive fishery for small cetaceans. There are no indications of interactions with fisheries, and Mitchell (1975a) describes it as rare in Japanese coastal waters.

Sousa chinensis Indo-pacific hump-backed dolphin
Leatherwood and Reeves (1983) describe this species as occurring up to the Canton River in southern China. There do not appear to be any interactions with fisheries recorded, but this is a coastal species which one might expect to be prone to net entanglement.

Peponocephala electra Melon-headed whale
Recorded in Japanese catch statistics of small whales infrequently, 140 were taken in a drive fishery in 1979 (Miyazaki 1983). There are no other indications of the abundance of this species, and no other obvious records of interactions with fisheries.

Feresa attenuata Pygmy killer whale
Rarely recorded worldwide, Nishiwaki et al (1965) reported 14 individuals captured in the Izu drive fishery. Almost nothing is known of this species' habits, but Nishiwaki et al report that the captured specimens ate sardines. Interactions with fisheries are therefore conjectural.

Pseudorca crassidens False killer whale
This species does not appear to be particularly uncommon, and Mitchell (1975a) states that it is commonly seen at sea. Mitchell also cites a number of Japanese authors in stating that it causes much damage to the tuna longline fishery. This species is not infrequently taken incidentally to other fisheries; Miyazaki (1983) records 32 in set nets between 1972 and 1981. Large numbers are also taken in drive fisheries, as well as by harpoon. Miyazaki (1983) records 1374 individuals taken in this way by drive and harpoon fisheries. Perhaps the best known of these fisheries occurs at Iki Island, where this species is one of those culled, largely for the reason that they are reported to damage the line fishery for yellowtail (Seriola quinqueradiata) in that area. Kasuya (1984 in press) has described the situation in detail. Between April 1976 and January 1982 953 false killer whales were killed in driving operations. This and other species are said to interfere with fishing operations on an offshore fishing ground, and at the same time as dolphin presence on the fishing ground was increasing, yellowtail availability was decreasing. Kasuya has investigated the diets of the four species involved, and concludes that Pseudorca is the only species "that interferes significantly and directly with the fishery for the share of yellowtail". The data, however, were too scanty to determine the extent of this competition.

Orcinus orca Killer whale
Occasionally taken by the small whale fishery in Japan, Miyazaki (1983) records a total of 12 taken in a 6 year period, by driving and by "small type whaling". Mitchell (1975a) cites Ohsumi (1972) in stating that this species is common mainly in northern waters. The report of the Killer Whale Workshop (IWC 1982) cites Nishiwaki and Handa (1958) in reporting the diet of this species in the northwest Pacific to include cod, flatfish, sardines, salmon, tuna, mackerel, atka mackerel, bonito, cephalopods and a wide variety of marine mammals. Clearly there is scope for a number of interactions with fisheries, although none seem to have been reported as yet.

Globicephala macrorhynchus Short-finned pilot whale
This species is commonly recorded amongst the incidental and commercial catch in Japanese

waters. Miyazaki (1983) reports 2 563 caught in the commercial fishery, and 133 caught in gill nets, seine nets and, mostly (119) in set nets. It is evidently not uncommon. The diet is thought to consist of squid, so competitive interactions with the squid fishery are quite possible.

Lagenorhynchus obliquidens Pacific white-sided dolphin
The diet and population numbers are summarized in the species accounts. This species is taken in drive and harpoon fisheries, and is also very frequently caught incidentally. Miyazaki (1983) reports a total of 241 caught in seine nets (55), gill nets (70), and set nets (16), over a 6 year period. This species is another which has been involved in the Iki Island controversy (see Pseudorca crassidens, above). A total of 466 were taken between 1976 and 1982 (Kasuya 1984 in press). Kasuya suggested that this species was not in competition with the yellowtail fishery.

Lagenodelphis hosei Fraser's dolphin
Fraser's dolphin was once thought to be very rare; Hammond and Leatherwood (1983) described them as the most conspicuous cetacean in one area of the Philippines. Miyazaki (1983) reports that this species is taken sporadically in set nets, strandings and other fisheries around Japan, so that its status and the extent of possible interaction with fisheries are not clear.

Tursiops truncatus Bottlenose dolphin
Tomilin (1967) suggests that Japan represents the northernmost limit of the distribution of this species. It appears to be fairly common, as Miyazaki (1983) reports a commercial catch of over 6 500 animals in a 6 year period, during which time 263 were also taken incidentally in set nets (254) and gill nets (9). Another of the Iki Island species, 4147 animals were taken between 1976 and 1982, but Kasuya (1984 in press) adds that yellowtail were not found in any of the stomachs examined. This species is also taken in unknown numbers in a drive fishery in Taiwan reportedly, in part at least, for "predation control" (Hammond and Leatherwood 1983).

Grampus griseus Risso's dolphin
Miyazaki's (1983) catch statistics record 723 of this species in the commercial catch between 1976 and 1981, and a further 75 caught incidentally in set nets. This is the fourth species involved in the Iki Island conflict, 525 having been taken between 1976 and 1981; Kasuya (1984 in press) goes on to state that this species lives exclusively on squid. The amount of competition between this, and other squid eating marine mammals, and local fisheries is unknown.

Stenella longirostris Spinner dolphin
This species does not occur often in the incidental or commercial catch statistics of Miyazaki (1983), who states that it is only taken sporadically, which suggests that it is not common in the northwest Pacific; there do not appear to be any readily available analyses on the abundance, or diet, of this species in this area.

Stenella coeruleoalba Striped dolphin
Nishiwaki (1975) describes this species around Japan. There is an extensive commercial fishery for this species, catches of which reached 20 000 per year, but which have subsequently declined (Nishiwaki 1975). In 1981, 4813 were taken (Miyazaki 1983). Nishiwaki states that the current population size around Japan is 0.4 - 0.6 million animals, whose main food is squid; squid fishermen catch this species occasionally, which is said not to bother them. Miyazaki's statistics indicate that Japanese incidental catches of this species are mostly in gill nets (750 in a 6 year period) with less caught in fixed nets (22 in the same period). Competitive interactions with squid fishery may be likely, but little seems to have been published on this problem, in English at least.

Stenella attenuata Spotted dolphins
Spotted dolphins are taken in drive fisheries in Japan - 7 505 having been taken between 1976 and 1981 (Miyazaki 1983), and also as incidental captures in set nets, 20 having been recorded over the same period. There are no obvious population estimates, but the above figures would suggest that, around Japan at least, spotted dolphins are not as common as striped dolphins.

Delphinus delphis Common dolphin
Commonly caught in gill nets and set nets, 128 and 171 animals were taken in each of these types of nets respectively, between 1976 and 1981 (Miyazaki 1983). Although there are no readily available analyses of the diet of this species in area 61, the diet seems very likely to include some commercial species, so that a certain amount of competitive interaction is also likely.

Lissodelphis borealis Northern right whale dolphin
This species is apparently caught in Japanese waters, although Miyazaki (1983) does not record the numbers involved, or the type of fishery. As squid have been recorded in some stomachs, competitive interactions with the squid fishery are always possible.

Phocoenoides dalli Dall's porpoise
There is an extensive fishery for this species in the waters around Japan, described by Miyazaki (1983), the mean annual catch exceeds 8 000. There are further mortalities through gill net and set net entanglements (544 and 102 respectively over 6 years : Miyazaki (1983). The North Pacific salmon gill net fishery also imposes a very high mortality on this species, which Jones (1983) has suggested may be as high as 40 000 animals per year for the whole North Pacific. The effect of all of these mortalities on the population is unknown at present, but Bouchet's (1983) total North Pacific and Bering Sea population estimate of 790 - 1 783 000 animals suggests that the estimated numbers of animals caught in fishing gear may be having a significant effect on the population. Wilke and Nicholson's (1958) data suggests a diet of squid and myctophids. The extent of any competition with fisheries for squid is not clear.

Neophocaena phocaenoides Finless porpoise
Marcuzzi and Pilleri (1971) state that this species is found in coastal waters as far north as Japan. Hammond and Leatherwood (1983) state that they are sufficiently common in the waters around Hong Kong that they can be found at least 1 day in 4 "usually in murky coastal waters". Further north, in Japan, Miyazaki (1983) records 5 finless porpoises being harpooned between 1976 and 1981, and a further 19 captured in set nets, and 2 in gill nets during the same period. If catch rates are an indication of abundance, this species cannot be among the more common ones in Japanese coastal waters. The extent of competitive interactions with fisheries are not clear, but the inclusion of prawns and shrimps in the diet would suggest some competition is possible.

Lipotes vexillifer Beiji
The size of the population of this species is unknown, but presumed small. Pei-Xun (1981) describes the situation suggesting that the decrease in numbers of this species may be due to fewer fish, and "the ruining of appropriate biotopes for Lipotes due to harnessing the river and increased navigation". The main threat, however, is said to be the hook fishery. About 50% of nearly 100 animals found dead between 1950 and 1980 had died from having eaten hooks.

Eumatopias jubatus Steller sea lion
At least 20 000 northern sea lions are thought to breed in the Kuril Islands and the Sea of Okhotsk (Mate 1982a). Mate states that in January sea lions appear off northern Hokkaido and then depart northward around May. Schusterman (1981) states that relatively little study has been made of the diet of this species, but that flatfish, rockfish, cod, pollock, smelt, greenling and some salmon have all been found. Invertebrates are also found to be important, especially bivalve and cephalopod molluscs. Mate (1982a) states that "competition with man for food may also be present though the trophic relations of the northern sea lion, other pinnipeds and man are poorly understood". He also states that 4 000 of these animals are captured incidental to fishing operations, though presumably many of these are in area 67.

Zalophus californianus Californian sea lion
Mate (1982) states that the population of this species which bred in the Sea of Japan is at best rare, and may be extinct.

Callorhinus ursinus Northern fur seal
The bulk of the population of this species is found in area 67, but there are breeding populations in area 61 on Robben Island, the Kuril and the Commander Islands which amount

to about 360 000 animals (Lander and Kajimura 1982). Feeding has been described in detail by Kajimura (1984) and by Perez and Bigg (1981), and is said to occur offshore, at areas of upwelling or over the continental slope (Gentry 1981). Food species include a wide range of commercial fish and squid. Herring, anchovy, salmon, capelin, saury, hake, pollock, rockfish, atka mackerel, sand lance and squids including Loligo opalescens are all listed by Lander and Kajimura (1982). They continue that "the competition between man, the fur seal and other forms of marine life, for certain stocks of fish, is a problem in resource allocation". Another of the points that Lander and Kajimura make is that survival rates in the population have been in decline; the recovery of the stock, after the cessation of female harvesting in 1968, did not occur as was predicted. Swartzman and Haar (1984) tested the hypothesis that this decline in survival rate might be due to a reduction in carrying capacity by commercial fishing operations. They conclude that this is not the case, and that in the 1970's fur seal consumption of one important fish, the pollock, actually increased. The competition between fur seals and fisheries is therefore still very unclear.

There is also a certain amount of incidental mortality to fur seals associated with fishing activities. Fukuhara (1974 cited in Lander and Kajimura 1982) estimates that between 3 150 and 3 750 northern fur seals are killed incidentally each year in the Japanese mothership fishery for salmon in area 61.

Odobenus rosmarus Walrus
Fay (1981) gives the southern limit of the distribution of this species as the Kamchatka Peninsular, though a few have reached Honshu. It is not clear how many of the estimated 140 000 (Brenton 1979) Pacific walruses move into area 61. There are no obvious records of interactions with fisheries, and apart from occasional net entanglements these would seem unlikely unless the benthic invertebrate fauna of the western Bering Sea becomes exploited.

Phoca vitulina Harbour seal
Occurring from north eastern Hokkaido, through the Kuril Islands to southern and eastern Kamchatka and the Commander Islands, with a population of perhaps 5 - 8 000, (Bigg 1981). Although the diet of this species often includes commercial species (Bonner 1979c) there appear to be few records of interactions with fisheries, possibly due to the relatively small population size and northerly distribution in this area. Naito (1976) reports some harbour seals being caught in salmon set nets and other nets, but no figures are available.

Phoca largha Largha seal
Distributed around the coast of area 61 from the Yellow Sea and the Po Hai Sea to Kamchatka and the Bering Sea (Bigg 1981). Bigg cites Tikhomirov (1966) in stating that this is the only seal harmful to commercial fish in the Sea of Okhotsk, but gives no further details. The population size is estimated at around 135 to 200 000 in the Sea of Okhotsk, 133 to 250 000 in the Bering Sea, and has not been estimated in the Po Hai Sea (Bonner 1979b). Naito (1976) states that this species is occasionally caught in nets, without giving any other details. Competitive interactions with fisheries are unclear.

Phoca hispida Ringed seal
There is one population of this species in the Sea of Okhotsk and around the Kurils (Stirling and Calvert 1979). Individuals are occasionally seen as far as Honshu, Japan, where they sometimes get trapped in salmon set nets and other nets (Naito 1976). A population size of 800 000 to 1 million is given by Frost and Lowry (1981), who also state that fish of the cod family and pelagic crustacea make up the bulk of the diet. Naito (1976) reports this species as being caught in nets occasionally, without giving details. The competitive interaction with fisheries is not clear.

Phoca fasciata Ribbon seal
Burns (1981) gives the southern limit of the distribution of this species as Hokkaido, and citing Shustov (1972) suggests a population in the Sea of Okhotsk of 140 000 animals. He also states that the diet is poorly known, but may include fish and crustacea. Interactions with fisheries do not appear to have been studied, but Naito (1976) refers to 3 ribbon seals caught in offshore gill nets around Japan.

Erignathus barbatus Bearded seal
The distribution of this species is very similar to the previous one in area 61, according to Burns (1981), though it does not extend as far south into the Sea of Japan. Naito (1976) states that bearded seals are seen rarely in Honshu, however, Stirling and Archibald (1979) give a population estimate for Soviet stocks, including area 18, as around 450 000; it is not clear what proportion of these are found in area 61. Feeding is on bottom dwelling invertebrates (Stirling and Archibald 1979), so competitive interactions with fisheries are unlikely; Naito (1976) states that this species is also occasionally taken in fishing nets.

This area together with area 67 is characterized by a large number of marine mammals, species and individuals, and intensive fisheries. Area 61 is also the most productive region of all. The high productivity, intensive fisheries and large number of marine mammals however, also means that many of the marine mammal species must be competing to some extent with fisheries.

Of the 50 species listed above, only walruses, bearded seals and 4 species of baleen whale are unlikely to consume commercial species. About 16 other species are known to feed on squid, which in this area is fairly heavily fished; it would seem that in contrast to most other areas of the world, where often only tens of thousands of tonnes of squid are caught, there is a possibility here that some squid eating marine mammals may compete directly with fisheries.

Of the remaining 28 species, most are thought to eat some commercial fish at least.

THE FISH STOCKS OF AREA 61

DEMERSAL FISH RESOURCES

Reported catches of demersal species in 1981 totalled around 9 million tonnes, to which should be added a proportion of the million tonnes of fish reported merely as 'marine fishes'. Most stocks are probably heavily fished Gulland (1983).

Gulland (1983) contrasts the northern areas of this region, the Sea of Okhotsk and Japanese coastal waters, which have relatively little shelf area, and in which demersal species are not so important, with the wide shelf areas of the Yellow Sea and East China Sea, where demersal species become more important.

GADIDAE

As in the North Atlantic waters, this family is the dominant one in the fisheries of the region.

Theragra chalcogramma Alaska pollock
This species is fished in what is the largest single species fishery in the world. Catches in area 61 are currently in excess of 3 million tonnes, and appear to be relatively stable over the past few years (FAO 1981). The species is widespread throughout northern parts of the area, and is thought to be fully exploited (FAO 1981). Alaska pollock are known to be an important food species of northern fur seals Callorhinus ursinus in the Sea of Japan and Sea of Okhotsk (Lander and Kajimura 1982), and are also eaten by a number of other species including fin and minke whales (Tomilin 1967). The effects of the fishery on these predators, or vice versa, is not known. Swartzman and Haar (1984) found that over a period of fishery expansion on this species, northern fur seal diets included progressively more pollock, though the size of fish eaten dropped.

They suggest this may be due to the fact that the fishery takes the larger fish, and as this species is cannibalistic, fewer large fish enable more smaller fish to survive. Clearly the dynamics of competition are not simple.

PLEURONECTIFORMES

The majority of the catch of flatfish (202 000 tonnes) is not broken down into species in the fishery statistics. Clearly this is an important fishery, but relatively few marine mammal species are known to include flatfish in their diets, these include killer whales, white whales, sea lions and possibly other pinnipeds.

Further south, the species composition changes and a number of more tropical species become important in the landings. There is some suggestion that stocks of demersal fish in the East China Sea may be overexploited (FAO 1981a).

SCIAENIDAE

As in other warm waters drums and croakers are amongst the most important commercial species. Yellow croakers (Pseudosciaena spp) are particularly important species, with catches exceeding 100 000 tonnes, but are reported to have fallen considerably (FAO 1981a), possibly as a result of over-exploitation.

Other important demersal stocks in area 61 include atka mackerel, Pleurogrammus azonus, which yielded 123 000 tonnes in 1981, a drop from 296 000 tonnes in 1976, and which is known to be included in the diet of killer whales in this region. Sandlance, Ammodytes personatus, have yielded catches of between 224 000 tonnes and 103 000 tonnes since 1976 (FAO 1983), and are known to be eaten by fin whales, minke whales, humpback whales and probably other species too.

PELAGIC FISH RESOURCES

The total pelagic catch in 1981 exceeded 7 million tonnes (FAO 1983). As with the demersal stocks, all stocks are said to be heavily fished (FAO 1981a). Gulland (1983) suggests that the pelagic species are more important than demersal ones in northerly areas around Japan and the Sea of Okhotsk. Many of these stocks have fluctuated in abundance widely (Nagasaki 1973).

CLUPEIDAE

Sardinops melanosticta Japanese pilchard
The largest fishery in the area is for this species which in 1981 yielded 3.6 million tonnes. The stocks have recovered dramatically from very low catches in the early 1960's (FAO 1981a). Distributed mainly in the coastal waters of Japan (FAO 1981) this species might be expected to provide food for a number of marine mammal species, although the only obvious references to this are for killer whales and pygmy killer whales (see above). Other coastal small cetaceans would seem likely to prey on such an apparently abundant fish, of which the common dolphin, which is known to feed on sardines extensively elsewhere (see area 37), springs to mind most readily.

Clupea pallasi Herring
Predominant in northerly waters around Sakhalin Island, the Sea of Okhotsk and the western corners of the Bering Sea, this species yielded 130 000 tonnes in 1981 (FAO 1983), down from 405 000 tonnes in 1973 (FAO 1978). Herring have been found in fin whales, minke whales, humpback whales, narwhals, white whales and fur seals, but this list is unlikely to be exhaustive.

Oncorhynchus spp. Salmon
Salmon are amongst the most important commercial species in this area. Six species are caught, and of these chum salmon are the most important in terms of weight, with over 100 000 tonnes taken in 1981; catches over all species totalled 150 000 tonnes (FAO 1983). The main spawning sites are in Kamchatka, but there are extensive gill net fisheries throughout much of the open sea in area 61, and in some coastal waters. Salmon are very frequently reported in the diets of marine mammals, as a cursory inspection of those species listed above should verify. Being an economically valuable fish, any predator on

salmon is likely to generate a certain amount of conflict with fishermen. The case of the grey seal in Scottish waters, however, should caution against assuming in all reported cases of salmon in marine mammal stomachs that this is an important, or even a regular diet item.

Other pelagic species which are important include mackerel and, as in other areas tuna. Various jacks and small clupeids, as well as the Pacific saury and some scads Decapterus spp.

INVERTEBRATE RESOURCES

CRUSTACEA

As elsewhere in Far Eastern waters, shrimps and prawns feature prominently as economically important resources particularly in the Yellow Sea. Over 300 000 tonnes were taken in 1981. Further north, crabs become more important, tanner crabs (Chionectes spp) are particularly important in Japanese coastal waters, and king crab (Paralithodes) is important in the Sea of Okhotsk (FAO 1981). The importance of such relatively large crustacea in the diets of marine mammals is not clear. One or two species, notably the finless porpoise in southerly waters, could be competing for some of these species.

CEPHALOPODS

Over 600 000 tonnes of cephalopods were reported in the catch statistics for area 61 in 1981 (FAO 1983). Japanese fisheries for cephalopods are described by Okutani (1977). At least some stocks of squid appear to be overfished at present. Okutani suggests that the jigging fishery for Todarodes pacificus may have had a significant impact on the stocks. Octopuses are also said to be fully exploited around Japan. Okutani, however, also points out the potential for the exploitation of oceanic squids of the family Ommastrephidae. The interaction between the squid fishery and marine mammals is a subject which has been very little studied. In view of the number of species which feed in whole or in part on squid, there is clearly scope for a great deal more study into this problem, particularly in an area such as this, where some squid stocks have already been heavily exploited, and where there also seems to be the scope for an increase in the fishery.

THE FISHERIES OF AREA 61

Gulland (1983) summarizes the fisheries of the region. In the north, Soviet vessels are principally medium to large vessels, mainly trawling for Alaska pollock. Japanese vessels are both small coastal vessels using a great variety of gears, and offshore vessels using seines and trawls. Distant water boats also trawl and gill net salmon. Zhu De-Shan (1980) describes the Chinese fisheries. Small motorized fishing vessels dominate, with some 1600 larger vessels. The main methods of fishing in the South China Sea are said to be trawling and also purse-seining, for scad, mackerel, round herrings and sardines. In the East China Sea, Yellow Sea and Po Hai Sea, gill netting and line-fishing supplement trawling and seining. According to Gulland (1983), Korean fisheries have developed in much the same way as the Chinese, but that very little is known of North Korean fishing activities. The fishery from the Chinese island of Taiwan is also one in which small to medium sized vessels are important, using a variety of gear in the coastal zone, and mostly trawls and purse seines offshore. The Korean purse seine fishery is known to take some small cetaceans as a by-catch (IWC 1982).

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 61

In the most productive fishery area in the world, where almost all the fished stocks appear to be either heavily fished or overexploited, and one where a great variety of marine mammal species are recorded, conflict would seem inevitable. Gear conflicts are commonplace in Japanese waters, and seem to be fairly extensively documented in Reports to the International Whaling Commission. Interactions in other areas, however, appear to

have received very little attention, or else are not readily available.

Operational interactions

1 The paper by Miyazaki (1983) summarizes all reported incidental captures of 14 species of small cetaceans over a six year period. Most commonly caught were striped dolphins, followed by Dall's porpoise, bottlenose and pacific white sided dolphins.

2 A significant by-catch for Dall's porpoise exists in northern Pacific waters in the salmon gill net fishery, which extend from area 61 into area 67. Total mortalities could be as high as 20 000 animals a year (Jones 1983).

3 Naito (1976) records 4 species of seal, ringed, harbour, largha and bearded which are occasionally taken in nets.

4 False killer whales are said to harass tuna longliners in this, and other, areas (Mitchell 1975a).

5 Humpbacks are once reported (Tomilin 1967) annoying salmon fishermen in Soviet waters.

6 Watson (1981) has recorded two unconfirmed captures of Ginkgo-toothed beaked whales on tuna longlines.

7 4 species of dolphin have been culled at Iki Island due to interference with the yellowtail fishery there, though this may also be seen as an expression of an assumed biological interaction.

8 The 1982 Small Cetacean Sub-Committee Report to the IWC indicated that some small cetaceans were taken incidentally in the Korean mackerel/purse seine fishery.

Biological interactions

A great number of biological interactions might be assumed to occur in this area. The squid fishery, in particular, may have brought a number of otherwise peripheral species into competition with fisheries. Despite some detailed work, there appear to be no obvious examples of such competition being proved to affect either marine mammals or fisheries. Clearly, considerably more analysis is required before the extent of these interactions will be even partly understood.

3.12 AREA 67: NORTHEAST PACIFIC

MARINE MAMMALS FOUND IN AREA 67

Eubalaena glacialis Right whale
The report of the Right Whale Workshop (IWC 1983 SC/35/Rep2) indicates that no population estimates are available for this species in the northeast Pacific, but a maximum one day count of 8 animals is recorded. Berzin and Vladimirov (1981) suggest a population size of around 2 - 500 for the whole North Pacific. Townsend's (1975) charts indicate that it was formerly an abundant species in these waters. Omura et al (1969) indicate that the diet in the North Pacific is confined to pelagic crustacea. There are no reports of interactions with fisheries.

Balaena mysticetus Bowhead whale
Migrations occur from the Beaufort and Chuckchi Seas in area 18, to the Bering Sea in winter. This stock was decimated in the last century (Tomilin 1967). The size of the stock has been estimated to be between 3390 and 4325 (Braham 1982). Fish are not consumed by this whale (Marquette et al 1982) and there is no indication of any interaction with fisheries.

Eschrichtius robustus Grey whale
Migrating from the Chuckchi and Bering Seas to California and Mexico to breed, Watson

(1981) states that these animals cross the Gulf of Alaska at speeds of around 185 km per day. Wolman and Rice (1979) suggest the population may number around 11 000. The food does not include fish, and no interactions with fisheries seem likely in this area at present.

Balaenoptera physalus Fin whale
The size of the population in area 67 is unknown, but Berzin and Vladimirov (1981) suggest between 14 and 19 000 individuals in the North Pacific. Tomilin (1967) describes feeding in the western North Pacific, which includes numerous fish species, mostly small shoaling ones such as capelin, herring, pollock and sand eels, as well as a variety of pelagic crustacea, and even some squid. Despite the presumed inclusion of fish in the diet, there appear to be no reported conflicts with fisheries.

Balaenoptera musculus Blue whale
Berzin and Vladimirov (1981) suggest a population of between 1 400 and 1 900 in the North Pacific. Fish are not eaten (Tomilin 1967) and no interactions seem likely.

Balaenoptera acutorostrata Minke whale
The population size in the eastern North Pacific is unknown, but a figure in the region of 100 000 animals might not seem too unreasonable. The diet in the North Pacific is said by Tomilin (1967) to include pollock, saffron, cod, herring, capelin, sand lance and pelagic crustacea. There do not appear to be any reports of interactions with fisheries, although clearly the diet may overlap with some commercial catches.

Balaenoptera borealis Sei whale
The population size in this area is unknown, but as Berzin and Vladimirov (1981) suggest between 8 600 and 21 000, for the whole North Pacific, a figure of less than or near to 10 000 animals might be reasonable for area 67. The food consists mostly of pelagic crustacea although squid and small amounts of fish may be taken too, according to Tomilin (1967). Rice (1977) however reports that off California at least, anchovies (Engraulis mordax) are the dominant food, and also states that they feed on saury (Cololabis saira) and jack mackerel (Trachurus symmetricus). Despite this, there are no reported conflicts between this species and fisheries.

Megaptera novaeangliae Humpback whale
Berzin and Vladimirov (1981) have suggested a population size of between 1200 and 1600 for the whole North Pacific; part of the North Pacific population migrates from the Chuckchee Sea to California and Mexico. The diet is said to include fish, and Rice (1977) found 60% of the diet was northern anchovy (Engraulis mordax) and 40% was krill (Euphausia pacifica). There appear to be no reported conflicts with fisheries, but with such a small population any entanglements could affect the population.

Berardius bairdii Baird's beaked whale
The population size is unknown, Laevastu et al (1980) have suggested about 10 000 for the North Pacific. The diet is thought to consist mostly of squid, and no interactions with fisheries have been reported.

Mesoplodon stejnegeri Stejneger's beaked whale
Recorded as far south as Monterey in California this species is said to strand fairly commonly in the Aleutians (Leatherwood and Reeves 1983) where it may be most common. The diet is presumably squid; there are no reported interactions with fisheries.

Mesoplodon carlhubbsi Hubb's beaked whale
Leatherwood and Reeves (1983) suggest a distribution from about 50^{O} to about 30^{O}N, this species is known from only a few standings. The diet is presumably squid, and no interactions with fisheries are recorded.

Ziphius cavirostris Cuvier's beaked whale
Known from as far north as the Bering Sea (Mitchell 1975), there are not enough data to estimate a population size. The diet is presumably mostly squid. There do not appear to be any interactions with fisheries.

Physeter macrocephalus Sperm whale
The population size in area 67 is not known, but could be in the tens of thousands. The diet includes squid and some fish, of which deepwater species including grenadiers, rockfish, sculpins and cods are most important (Berzin 1972). Authorities differ as to the importance of fish in sperm whale diets in this area. There are no apparent conflicts with fisheries in area 67.

Monodon monoceros Narwhal
Mitchell (1975) and Tomilin (1967) state that this species is confined to the Arctic Ocean, but Leatherwood and Reeves (1983) suggest the range may extend into the Bering Sea. The diet is known to include commercial fish (Tomilin 1957), but this species is presumably not very frequently found in area 67, and conflicts seem unlikely.

Delphinapterus leucas White whale
Mitchell (1975) states this species is found in the subarctic, in shallow water. The population size in area 67 is unknown, but Gurevich's (1980) review suggests a population in the thousands. The diet in this region is reported to include salmonids, herring, navaja, flatfish and smelt (Gurevich 1980). Lowry and Frost (1984 in press) noted that this whale has already been perceived as a threat by salmon fishermen in Bristol Bay, where during the 1950's white whales were scared away from salmon runs with reportedly improved recovery of sockeye stocks. These authors, whilst noting the lack of adequate data on feeding and trophic relationships in the area, suggest that there may be potential for interaction between white whales and fisheries, although "their mobility may reduce the probability of significant interactions with fisheries". Mate (1980) reports that white whales damage gill nets in Alaska but do not remove fish; they feed seasonally on smelt and salmon, and have been excluded successfully from the Kvichak river estuary where they consume salmon smolts, by recorded killer whale sounds (Fish and Vania 1971).

Orcinus orca Killer whale
The population size in area 67 is unknown. McAlister (1981) has suggested a figure of around 1 000 in the Bering Sea alone, in summer. The population for the whole of area 67 might be as many as 10 000 as a very rough estimate. The diet has not been studied in detail in this region, but Braham and Dalheim (1982) suggest that fish are eaten when locally abundant, but marine mammals are eaten when fish are scarce. Tomilin (1967) included herring, cod, skates, smelt, capelin, halibut, sharks and salmonids amongst the fish eaten by this species. Matkin and Fay (1984) state that killer whales are associated with salmon fisheries, but have not been considered as major contributors to any conflicts. Mate (1980) states that killer whales are said to frighten salmon in British Columbia, making them difficult to catch.

Globicephala macrorhynchus Short-finned pilot whale
There are no population estimates for area 67, but this species only occurs as far north as the Gulf of Alaska (Mitchell 1975). Feeding is presumably mostly on squid, and there appear to be no records of interactions with fisheries, although squid fishermen have been annoyed by this species in California (see area 77).

Lagenorhynchus obliquidens Pacific white-sided dolphin
Leatherwood and Reeves (1983) state that this species ranges as far north as the Bering Sea. The population size is unknown, but seems likely to number in the tens of thousands. The diet is thought to include hake (Merluccius productus), anchovies (Engraulis mordax), and squids, so that some competition with fisheries may occur for prey species. There do not appear to be any records of conflicts however.

Grampus griseus Risso's dolphin
This species is recorded as far north as British Columbia (Mitchell 1975), but there are no estimates of its abundance in area 67. The diet is generally presumed to consist mostly of squid, and there are no obvious records of any interactions with fisheries in this area.

Stenella coeruleoalba Striped dolphin
Marcuzzi and Pilleri (1971) both record this species as far north as the southern Bering Sea, around the Aleutian Islands. Data on abundance are lacking in this area but a population in the hundreds of thousands might be expected. The diet is elsewhere known to consist of small mesopelagic fish. There do not appear to be any records of inter-

actions with fisheries in this area.

Lissodelphis borealis Northern right whale dolphin
Rice and Scheffer (1968) record this species as far north as British Columbia. The population size in the North Pacific has been estimated at around 40 000 by Laevastu et al (1980). The diet has been found to include squids and lantern fish, and there are no apparent interactions with fisheries in this area.

Phocoena phocoena Harbour porpoise
This species is said to occur as far north as Point Barrow in Alaska. The population in the North Pacific has been estimated at around 20 000, 5 000 of which may occur in the eastern Bering Sea, Gulf of Alaska and west coast of America (Laevastu et al 1980). McAlister (1981) states that the diet of this species consists mostly of bottom fish such as cod, herring, fry, flounder, and only rarely any invertebrates. Lowry and Frost (1984 in press) suggest that this species has a reasonably high potential for interaction with fisheries in the Bering Sea as it forages extensively on commercial species, although its mobility may reduce the probability of significant interactions. Matkin and Fay (1984) also list this species as one which is of minor importance in interactions with salmon fisheries in southeast Alaska, and estimate that around 50 may die in salmon net entanglements per year in one particular fishery.

Phocoenoides dalli Dall's porpoise
The population in the North Pacific and Bering Sea may number around 1 million animals (Bouchet 1983). The diet consists mostly of lantern fish but also includes squid, saury, hake, herring, jack mackerel, bathypelagic and deepwater benthic fish (Crawford, cited in McAlister 1981). Lowry and Frost (1984) do not rate this species particularly highly as a potential competitor with fisheries, though this is due in part to the fact that they suggest the population of this species may currently be depleted as a result of incidental captures and mortalities. Mortalities in high seas drift net fisheries for salmon are high, and may number as many as 20 000 in the whole of the North Pacific. Matkin and Fay (1984) found this species to be of minor importance in operational interactions with salmon gill net fisheries in southeast Alaska.

Eumatopias jubatus Steller sea lion
Distributed throughout the continental shelf waters from the Bering Sea south to California, breeding occurs from the Pribilof Islands southward to California. The population breeding in area 67 has been estimated at slightly less than 200 000 (Mate 1982a). The diet is known to include a number of commercial species and includes pollock, flatfish, rockfish, capelin, sandlance, sculpins and salmon. In their study of biological interactions between marine mammals and commercial fisheries in the Bering Sea, Lowry and Frost (1984 in press) find this to be one of the 3 species for which there is greatest potential for interactions with fisheries, based on their feeding habits and demography. Operational interactions are reported by Matkin and Fay (1984) in southeast Alaskan salmon gill net fisheries, where marine mammals do an estimated $350 000 damage per year to gear and catch. Most of this damage is attributed to sea lions and harbour seals. About 400 sea lions are thought to be killed in this fishery. Everitt et al (1981) also report damage to salmon gill net fishery catch and gear in Washington, some of which is attributed to steller sea lions. Loughlin and DeLong (1983) report steller sea lions becoming trapped in trawl nets in the US-South Korean joint venture fishery for walleye pollack in the Shelikof Strait, Alaska. In 1982, 1 393 sea lions are estimated to have been killed in trawl nets, and a further 222 in 1983, the difference being possibly due to differences in location and dates of the fishery in the two years. Mate (1980) reports that this species is also responsible for removing halibut and sablefish from longlines in Alaska waters; it is claimed that up to 50% of the sablefish in a Japanese longline fishery south of the Pribilofs may be damaged in this way. It seems likely that incidental kills occur throughout the range of this species, but detailed data have been collected from only a few sites. Conflict with fishermen would also appear to be widespread.

Zalophus californianus Californian sea lion
Odell (1981) considers the range of this species to extend as far north as British Columbia. The population size is unclear, but in area 67 probably numbers in the tens of thousands (total population 75 - 100 000 Mate 1982). The diet is not well known

either, but may include hake, northern anchovy and cephalopods amongst the other species. Operational interactions between this species and fisheries are widespread. Everitt et al (1981) report this problem in Washington State coastal waters, where, in one salmon drift net fishery, up to 30% of the catch may be damaged by marine mammals, including sea lions. Competitive interactions would seem to be possible, although no detailed analysis of this problem has been yet made. This species has been blamed however, for a decline in the salmon catches of sport fishermen in Washington and Oregon (Mate 1980).

Callorhinus ursinus Northern fur seal

Gentry (1981) describes the distribution of this species in the eastern Pacific from around the Pribilof Islands in the Bering Sea, around the shelf area of North America as far as California. This part of the population he estimates at around 1.3 million animals. The feeding habits of this species in area 67 are discussed exhaustively by Perez and Bigg (1981) and by Kajimura (1984 in press). The diet is varied and includes more than 50 species, the principle ones being walleye pollock (Theragra chalcogramma), capelin (Mallotus villosus), atka mackerel (Pleurogrammus monopterygius), herring (Clupea harengus), northern anchovy (Engraulis mordax), Pacific whiting (hake) (Merluccius productus), Pacific saury (Cololabis saira), rockfish (Scorpaenidae) and in some areas salmon. This diet and the abundance of fur seals in the Bering Sea lead Lowry and Frost (1984 in press) to conclude that this species is one of the most likely to compete with fisheries in that area. Swartzmann and Haar (1984 in press) have examined the hypothesis that the increased fishing effort on, and catches of, walleye pollock, one of the fur seals' major foods, might be responsible for a decrease in fur seal survival rates in the Bering Sea, and for the current decline in the fur seals abundance. Their analysis did not support this hypothesis, suggesting that fur seals' consumption of pollock had increased after the fishery started. This study, which was based on extensive feeding data, is one of the few to have attempted to link a marine mammal's population dynamics with the activities of a fishery, and yet despite Lowry and Frost's finding that this species is very likely to compete with fisheries, no such effect on the population dynamics or feeding behaviour was found.

Operational interactions between fur seals and fisheries are widespread, and in particular, there is increasing concern that floating fishnet scraps, especially from the salmon drift net fishery may be having some serious effect on the population. Fowler (1982) examined the relationship between fur seals and fisheries and also concluded that competition was not the cause of reduction in fur seal numbers. He suggests that entanglement may be responsible for a large part of the observed decline, with 5% or more of the population dying this way, as more than 50 000 seals per year.

Odobenus rosmarus Walrus

Confined to the Bering Sea, in area 67, the population in the Bering-Chuckchi region is thought to number around 200 000 animals (Fay 1981). The walrus diet consists mainly of benthic invertebrates. Lowry and Frost (1984 in press), and Harwood (1981), have pointed out the potential for competitive interactions between this species and fisheries. Walruses are said to show little feeding plasticity, specializing in sedentary organisms, for which at present there is no commercial interest. Should a fishery for such prey items ever develop, some conflict would seem probable.

Phoca vitulina Harbour seal

This species is said to be littoral in distribution and non-migratory, the population in area 67 extending from the Bering Sea to California (Bigg 1981). The population size in ths area is not known, but may number more than 250 000 (Laevastu et al 1980). Feeding is said to be opportunistic and includes a wide variety of fish (Bigg 1981). Lowry and Frost (1984 in press) found this to be one of the most likely species to compete for food with fisheries in the Bering Sea, especially for pollock, herring and salmon.

Operational interactions are widespread with regard to this species. Mate (1980) reports that harbour seals are a particular nuisance in the Copper River Delta and Bristol Bay salmon gill net fisheries. Matkin and Fay (1984) found that this was one of the 2 principle species involved in damage to catch and gear of 2 salmon gill net fisheries in southeast Alaska, which amounted to a loss of about $350 000 per year. In addition, around 500 harbour seals are thought to die in salmon gill nets in the region, although this is said to have little effect on the population dynamics of this stock. In

Washington State, harbour seals are implicated as the main cause of significant damage and loss to the catch of further salmon gill net fisheries (Everitt et al 1981). Mate (1980) states that up to 30% of the catch in the Columbia river salmon fishery may be damaged, mostly by harbour seals, and that this species has also been blamed for a decline in catches by sport fishermen.

Phoca largha Largha seal
This species is closely related to the preceding one, but breeds on ice, and not on land; the distribution is therefore confined to the Bering Sea, where up to 250 000 animals may breed (Bigg 1981). As this species feeds more extensively in northern waters of the Bering Sea, Lowry and Frost (1984 in press) suggest that it may not be as likely to compete with fisheries as the harbour seal. Operational interactions are likewise limited by this species' habitat.

Phoca hispida Ringed seal
This is another of the so called 'ice seals', confined in area 67 to the northern Bering Sea (Frost and Lowry 1981). Up to 200 000 ringed seals may occur in the eastern Bering Sea for parts of the year (Laevastu et al 1980). The diet is said to consist largely of arctic cod (Boreogadus saida) and a large zooplankton. For this reason, and because of its remote habitat, interactions with fisheries seem unlikely.

Phoca fasciata Ribbon seal
Confined to the Bering Sea, up to 100 000 animals may be present for part of the year in the eastern part (Laevastu et al 1980). The diet is poorly known, but may include crustaceans and fish (Burns 1981). Interactions with fisheries seem unlikely.

Erignathus barbatus Bearded seal
The population of bearded seals in the eastern Bering Sea may reach 250 000 for part of the year (Laevastu et al 1980). The diet consists mostly of benthic organisms, but some schooling demersal fish are also taken (Burns 1981). The diet and remote habitat would seem to make interactions with fisheries unlikely at present.

Mirounga angustirostris Northern elephant seal
This species ranges up the western American coast as far as British Columbia, although the breeding sites are all in area 77. The proportion of the estimated 50 000 individuals in the population which feed in area 67 is not known. The diet consists mostly of deepwater fish, competition seems unlikely. There appear to be no records of gear conflicts in area 67, although occasional entanglements might be expected.

The diets and population sizes of marine mammals in this area are possibly better known than in any other statistical area. In recent years much attention has been given to the problem of marine mammal interactions with fisheries in this area, possibly because of the valuable salmon fishery, which is often perceived to compete with marine mammals and possibly because, in the Bering Sea at least, the density of marine mammal biomass appears to be quite high. The area is also well supplied with suitable fishery centres for the study of this problem, notably the Northwest and Alaska Fisheries Center.

Of the 33 species listed above, at least 15 are known to consume some commercial fish, notably anchovy, herring, pollock and salmon.

7 other species appear to be largely squid eating, although of these sperm whales and pilot whales also consume fish, in uncertain quantities. Of the remaining species, 3 are baleen whales which do not consume fish, grey whales and walruses eat invertebrate benthos and other non commercial species, striped dolphins and northern right whale dolphins appear to feed on non commercial fish such as myctophids, whilst elephant seals consume mainly deepwater fish species. Finally 3 ice seals are both remote and unlikely to compete with fisheries anyway.

THE FISH STOCKS OF AREA 67

DEMERSAL FISH RESOURCES

Demersal fish resources are fished on the shelf area of the Bering Sea, in the Gulf of Alaska and to a lesser extent down the narrow shelf of the North American coast. The fisheries in this area are said to be closely controlled by the coastal states (FAO 1981a), so that many of the stocks appear fairly healthy. The catch in 1981 was around 1.6 million tonnes for all demersal finfish (FAO 1983).

GADIDAE

Theragra chalcogramma Alaska pollack
This is the largest single species fishery in the area, with catches in 1981 exceeding 1 million tonnes (FAO 1983). Gulland (1983) states that this species is pretty close to being fully exploited, and that not much of an increase in sustained yield can be expected. This fishery appears to be pursued largely by foreign vessels in area 67, and especially in the Bering Sea. Pollack are important food for a number of marine mammal species, as already noted. The fishery on this species seems to have had unpredictable effects on the feeding of some marine mammals at least. Swartzman and Haar (1984 in press) found that over the period of the fishery small pollack increased in the diet of fur seals. They suggest this may be due to an increase in smaller fish as the fishery removes larger, cannibalistic fish.

Gadus macrocephalus
Pacific cod are found over much the same area as pollack, in the southern Bering Sea and along the Aleutian ridge. The catch in 1981 was 100 000 tonnes, which is about what the estimated potential is (90 000 tonnes : FAO 1981), but there are suggestions (FAO 1981b) that this species may be increasing in abundance.

Merluccius productus
North Pacific hake or whiting have an estimated potential of 150 000 tonnes (FAO 1981), slightly more than the reported catch of 120 000 tonnes in 1981 (FAO 1981a). The distribution is along the north west American coast, as far north as British Columbia. This is an important diet item of a number of species, especially the sea lions and fur seal.

PLEURONECTIFORMES

Limanda aspera
Yellowfin sole have been heavily fished in the past, but may now be increasing in abundance (FAO 1981a). The main area of concentration of this species is in the southern Bering Sea. In 1981 the catch was only 77 000 tonnes (FAO 1983). Few marine mammal species, other than bottom feeders, might be expected to feed on this species but it is not an unimportant commercial stock.

Other important demersal stocks include halibut (Hippoglosus stenolepis) which is fished all along the shelf edge, with a total catch in 1981 of over 15 000 tonnes. The stock was heavily fished by the local longline fishery, but has recovered under management (Chapman et al 1962), but trawl fisheries for other species may be affecting catches of halibut through a significant by-catch of young halibut. There is reported to be some depredation of halibut caught on longlines by steller sea lions, although this may not be as widespread as in previous decades when the fishery was larger (Mate 1980).

PELAGIC FISH RESOURCES

Gulland (1983) states that in general pelagic resources are not abundant enough to attract foreign vessels, and do not fetch high enough prices to attract local vessels. The exception to this is salmon. The total potential for the area has been estimated at 1.2 million tonnes, but catches totalled less than half a million tonnes in 1981 (FAO 1983).

Clupea pallasi
Herring is one of the very few pelagic species fished for in this area at present. The catch in 1981 was 83 000 tonnes (FAO 1983), and except locally, e.g. around Vancouver Island, the stocks are lightly fished. Herring are known to be eaten by a number of marine mammal species, but with such light fishing, competition with fisheries may not be important.

Oncorhynchus spp. Salmon
The catches in 1981 totalled 364 000 tonnes, and are taken by purse seines, gill nets and by trolling. The fleet size is grossly in excess of what is needed to take this volume of catch, and the maintenance of an adequate spawning is only assured by very strict control on the type, location, and timing of commercial fishing. There are also important native American and sport fisheries. Salmon, by virtue of their market value, are always an important fish to consider in the interaction of marine mammals and fisheries. This is especially true in this area where salmon and marine mammals are both so abundant. Almost all the fish eating marine mammals in this area are known to include at least some salmon in their diets. More importantly perhaps, one of the main fishing methods, gill netting, seems particularly prone to depredation and damage by pinnipeds. Conflict in this area would seem to be quite unavoidable at present given the abundance of marine mammals, the value of the catch, and the methods of fishing.

INVERTEBRATE RESOURCES

CRUSTACEANS

Although several marine mammal species are known to feed on crustaceans, these are mostly pelagic, and there is little conflict with fisheries. The main crustacean fisheries are for king crabs (Paralithodes spp) and snow crabs (Chionectes spp), although some shrimps are also taken.

CEPHALOPODS

Reported catches of cephalopods in area 67 in 1981 were trivial, amounting to less than 5000 tonnes (FAO 1983). Voss (1973) has suggested a total potential of more than 600 000 tonnes. Fiscus (1982) has studied the predation of squid by marine mammals in this area, but in the absence of squid fisheries, interactions are not significant.

THE FISHERIES OF AREA 67

The catches in this area show an interesting split between local and foreign fleets. Japan takes the largest catch (900 000 tonnes in 1981), but most of this is made up from Alaska pollack, with smaller amounts of flatfish, Pacific cod and hake. These stocks are fished by Japanese trawlers. In contrast to this, U.S. and Canadian catches amounted to just over 950 000 tonnes, more than a third of which was salmon. The exploitation of other commercially valuable species such as crabs is also confined to the coastal states (FAO 1983, Gulland 1983).

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 67

In an area where marine mammals are said to consume more fish than the total catch by fishermen (Laevastu and Favorite 1977), interactions between the two are certain to take on great significance. In an area where salmon is also the most important catch, and where efficient gear is explicitly banned, conflict between fishermen and pinnipeds in particular, would seem inevitable.

Operational interactions

The limited number of fisheries in this area limits the number of potential gear conflicts; the salmon gill net fishery appears to be the main area of conflict, though no

doubt other, less well reported cases exist in the other fisheries, especially the Canadian and U.S. coastal fisheries.

1 Salmon gill nets have been reported as major areas of conflict. There is often severe depredation of fish, and also damage to the gear. The marine mammals involved appear to be mainly pinnipeds, especially harbour seals and sea lions. Some incidental mortalities to marine mammals are also reported for these conflicts. Mate (1980) also reports harbour seals and sea lions affecting salmon troll fisheries in British Columbia.

2 Drifting scraps of monofilament net, which does not decompose are trapping and often killing what may be very large numbers of marine mammals, most notably the Northern fur seal. There are few data on this at present.

3 Halibut and sablefish longline fisheries are affected by sea lions taking caught fish.

4 Killer whales are said to frighten salmon, making them difficult to catch (Mate 1980).

Biological interactions

The problem of biological interaction between marine mammals and fisheries in this area has received considerable scientific attention, particularly from the Northwest and Alaska Fisheries Center, at Seattle. Laevastu and Favorite (1977) have estimated the amount of finfish consumed by marine mammals in the Bering Sea, which they put at around 2.4 million tonnes. Such quantities of fish consumed might help to argue strongly that competition between marine mammals and fisheries in the area is intense.

Although it has generally been agreed that the consumption of commercial fish by marine mammals represents a very large tonnage of fish, the mechanics of the competition between the two 'predator' groups has proved more difficult to assess. One of the few such analyses was unable to find any causal connection between an increase in fishing effort and catch by the pollack and herring fishery, and a decrease in the survival rate of one of their major predators, the Northern fur seal. Contrary to expectation, the predation on pollack was thought to have increased during the period of increased fishing.

In this area as elsewhere, competition between marine mammals and fisheries has proved difficult to demonstrate, even if it is generally accepted by fishermen and fisheries scientists alike, to be important.

3.13 AREA 71: WESTERN CENTRAL PACIFIC

MARINE MAMMALS FOUND IN AREA 71

Balaenoptera physalus Fin whale
Known to occur in "all seas" (Hershkovitz 1966), like most baleen whales, this species has rarely been recorded in the tropics. Soegiarto and Polunin (1982) confirm the presence of this species in the Java Sea, listing it as one of the cetacean species occurring in Indonesian waters. There are no abundance estimates, nor any information on feeding in this area. There are no apparent records of interactions with fisheries either.

Balaenoptera musculus Blue whale
Tomilin (1967) states that this species is virtually cosmopolitan, preferring the open sea, and shunning the tropics. Soegiarto and Polunin (1982) record it as present in Indonesian waters, with records from South Java and the Savu Sea. There are no estimates of abundance, nor any information pertaining to feeding. The population would seem unlikely to exceed a few hundred at most at any time of the year. Interactions with fisheries are not recorded and would seem unlikely.

Balaenoptera acutorostrata Minke whale
Recorded by Soegiarto and Polunin (1982) from the Straits of Malacca, North Sumatra, South Java and the Savu Sea. There are no obvious indications of any population estimate, feeding data or records of interactions with fisheries. The population would seem unlikely to exceed a few tens of thousands at most, at any time of the year.

Balaenoptera borealis Sei whale
Recorded by Soegiarto and Polunin (1982) from Kalimantan, Java and the Savu Sea. There are no obvious population estimates nor information on feeding for area 71 and no records of interactions with fisheries. A population estimate of many more than a few thousand might not be considered reasonable.

Balaenoptera edeni Bryde's whale
Recorded from the Straits of Malacca and the Savu Sea by Soegiarto and Polunin (1982). Once again there do not appear to be any detailed data on this species in this area. The population may presumably be less transient than other baleen whales in the area, and by comparison with other areas some fish might be eaten.

Megaptera novaeangliae Humpback whale
Townsend's (1935) charts record catches in the Marianas and in the Coral Sea. Soegiarto and Polunin (1982) also provide a sighting record for eastern Indonesia. Once again there are no detailed data on this species in this area. The population in the area would be unlikely to exceed a very few hundred at present.

Mesoplodon pacificus Longman's beaked whale
The first of only two specimens of this species was recorded from Queensland Rice and Sheffer 1968). There are no other relevant data on this species, which must be considered very rare at present.

Mesoplodon densirostris Blainville's beaked whale
Soegiarto and Polunin (1982) record this species from eastern Papua New Guinea. There appear to be no other records in this area but it is generally presumed to inhabit waters throughout area 71 (Leatherwood and Reeves 1983). There are no detailed data on this species in this area, but like all Mesoplodon species, it does not appear to be common.

Mesoplodon layardii Straptoothed whale
Watson (1981) records this species from northern Queensland. It is not known from any other parts of area 71; the population must be considered small.

(Mesoplodon bowdoini Andrew's beaked whale
If Nishiwaki's (1962) record of this species in Japan indicates a population there, then the distribution may extend through area 71 to New Zealand where it is recorded by Leatherwood and Reeves (1983))

(Mesoplodon ginkgodens Ginkgo-toothed whale
This species has been recorded in Japan and Ceylon, and so may presumably inhabit area 71 also, but as yet there are no records).

Ziphius cavirostris Cuvier's beaked whale
Known from all seas, Soegiarto and Polunin (1982) record this species from the Java Sea and the Savu Sea. There are no detailed data from area 71.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps show a scattering of catches in the east, around New Guinea and on the equator (On The Line). More recently catches of this species have been made from 2 whaling villages on the Island of Lomblen, Nusu Tenggara, in eastern Indonesia. There do not appear to be any estimates of population abundance in this area, and no interactions with fisheries are reported. A population of more than a few hundred thousand may be unlikely.

Kogia breviceps Pygmy sperm whale
Generally assumed to live in tropical warm seas (Mitchell 1975 e.g.). Soegiarto and Polunin (1982) provide sightings records of this species from Kalimantan and Nusu

Tenggara in Indonesia. Whilst Mitchell (1975), citing Weber (1923), states that this species was hunted, and may still be hunted by villagers in Nusu Tenggara. There are no data on abundance or feeding, but this does not appear to be a common species anywhere. Interactions with fisheries seem unlikely at present.

Kogia simus Dwarf sperm whale
Another uncommon species, Soegiarto and Polunin (1982) record this whale from the Savu Sea. There do not seem to be any detailed data from this area, and interactions with fisheries would seem unlikely.

Steno bredanensis Rough-toothed dolphin
Tas'an and Leatherwood (1983) refer to the occurrence of this species off northern Java. There do not appear to be any more detailed data than this for area 71; it is a rarely seen oceanic species, and may be considered unlikely to interact with fisheries.

Sousa chinensis Indo-Pacific hump-backed dolphin
Soegiarto and Polunin (1982) state that this species is found in all coastal, generally muddy, waters in Indonesia. Leatherwood and Reeves (1983) state that its range extends up towards Japan. Bannister (1977) records the incidental capture of this species in shark nets in Queensland, but says only that 13 small cetaceans have been recorded in nets in one area in one year. It would seem likely that this species is caught quite frequently in nets along most of the coasts of this area, but data are lacking.

Orcaella brevirostris Irrawaddy dolphin
Recorded by Soegiarto and Polunin (1982) in all coastal muddy waters of Indonesia, and in the river Mahakam in Kalimantan. Watson (1981) states that they are still fairly common throughout their range. Bannister (1977) records them in shark nets off Queensland, but it is not clear how many. Tas'an and Leatherwood (1983) describe a population in Semayang Lake, Kalimantan, which feed on carp (Cyprinidae), 14 of which were captured and transported alive to Jakarta. This species is another which seems likely to be involved in incidental captures throughout the area, but for which data are lacking.

Peponocephala electra Melon-headed whale
Recorded by Soegiarto and Polunin (1982) in the Savu Sea, Hammond and Leatherwood (1983) describe this species as common around the Philippines. There are no obvious data on feeding for this species with fisheries. The fact that they are described as common, around the Philippines at least, suggests that some incidental capture is most likely.

Feresa attenuata Pygmy killer whale
The range is presumed to include area 71, though the only obvious record is given in Soegiarto and Polunin (1982) as a possible sighting in eastern Nusu Tenggara. There are no data on feeding or interactions with fisheries in this area; interactions would seem unlikely at present.

Psuedorca crassidens False killer whale
Soegiarto and Polunin (1982) give a number of records of this species from throughout Indonesia. Marcuzzi and Pilleri (1971) suggest that it is pelagic and oceanic. Bannister (1977) records an unknown number which are caught in shark nets off Queensland. Harwood et al (1983) found one amongst 46 identified small cetaceans caught in the Taiwanese gill net fishery for tuna, mackerel and sharks, off Northern Australia. It is not clear if this was in area 57 or 71, but such catches are presumably likely in both areas. These incidental captures of this species in Australian waters suggest that other captures may occur in other waters of area 71, but so far have not been reported. The status of the population is unclear. Mitchell's (1975a) suggestion that it causes damage to tuna longlining fisheries may be relevant to this area.

Orcinus orca Killer whale
Soegiarto and Polunin (1982) record this species from Kalimantan and the Savu Sea. There seem to be few other records of this species in this area, although Sivasubramanian (1964) states that it damages tuna longlining fisheries throughout this area as well as the Indian Ocean. There are no abundance estimates, nor feeding data for this area, and apart from damaging tuna longlines and catch, no other records of interactions.

Globicephala macrorhynchus Short-finned pilot whale
Recorded by Soegiarto and Polunin (1982) from Java, Sumatra and the Savu Sea. Leatherwood and Reeves (1983) states that its distribution in the southern hemisphere is poorly known. No interactions with fisheries are recorded.

Lagenodelphis hosei Fraser's dolphin
Hammond and Leatherwood (1983) state that in a 100 mile radius around Cebu City, the Philippines, this was the most conspicuous species, frequently encountered, usually in large herds. They are thought to inhabit the entire area (Perrin et al 1973a). Not yet recorded in any interactions with fisheries in this area, these would seem likely in seine or gill nets, if they are as common in the rest of area 71 as they appear to be around Cebu City.

Tursiops truncatus Bottlenose dolphin
Apparently common throughout the area, it is reported in a number of gear conflicts. Tas'an and Leatherwood (1983) record the incidental capture of one individual, "accidentally netted by fishermen near Manago, northeast Sulawesi". Harwood et al (1983) report that 36 out of 46 identified small cetaceans caught in Taiwanese gill nets off Northern Australia were bottlenose dolphins. They estimate that more than 2 000 small cetaceans are killed this way every year, a high proportion of which are presumably this species. This may have a significant effect on any local population, but there are no data published on such effects.

Grampus griseus Risso's dolphin
Reported by Soegiarto and Polunin (1982) in the South China Sea, Leatherwood et al (1983) were also informed that this species inhabits the waters around Penang. There are no indications of abundance in area 71, apart from general comments that they are 'relatively common' (Watson 1981). No interactions with fisheries are apparent in this area.

Stenella longirostris Spinner dolphin
Known to occur throughout the area, Tas'an and Leatherwood (1983) report the incidental capture of 9 in the Java Sea, adding that they are generally found away from shallow coastal waters. Harwood et al (1983) report the presence of 6 of this species out of 46 identified cetaceans in gill nets off the north Australian coast. They estimate that more than 2 000 small cetaceans are caught in this way every year. Bannister (1977) states that at that time no purse seining on dolphin associated tuna was carried out in Australian waters.

There are no other apparent cases of this species interacting with fisheries in this area, but as inshore fisheries are known to include it as a by-catch in India (Jones 1976), such incidents cannot be ruled out in this area, which also has extensive inshore fisheries.

Stenella coeruleoalba Striped dolphin
Although recorded by Soegiarto and Polunin (1982) in the Java and Savu Seas, there do not appear to be any reported interactions with fisheries in this area, nor any indication of population abundance.

Stenella attenuata Spotted dolphin
Hammond and Leatherwood (1983) report sightings, on half a dozen occasions, groups of 2 - 800 spotted dolphins off Cebu in the Philippines. This species has been reported in small numbers (3 out of 46 identified cetaceans) in the gill net fishery off North Australia. There are no indications of abundance, but this is generally a common species. There are no other obvious recorded interactions with fisheries in this area.

Delphinus delphis Common dolphin
Seen in the Straits of Malacca by Leatherwood et al (1983), this species does not appear to have been recorded in any incidental captures in this area, although this might seem likely. There are no indications of abundance, but elsewhere this seems to be a common species. There are no indications of diet in this area either.

Neophocaena phocaenoides Finless porpoise
Leatherwood and Reeves (1983) state that this species is distributed in coastal waters

throughout Indonesia, and northwards to Japan. Tas'an and Leatherwood (1983) record 2 individuals caught accidentally in gill nets off northern Java. For such a coastal species it would be surprising if more such interactions were not recorded. Leatherwood and Reeves (1983) state that the diet consists of small squid, prawns and shrimps, as well as small fish.

Dugong dugon Dugong
Known to occur throughout most of this region (Bertram and Bertram 1973), the dugong population has been seriously affected by accidental mortalities in gill nets. Soegiarto and Polunin (1982) state that "Indonesia remains an important refuge for the dugong in southern Asia. There is little information on its populations, for as everywhere it is an elusive and sensitive animal". About 1 000 animals are taken per year around the island of Aru in eastern Indonesia (Compost 1980). Heinsohn (1972) states that after the introduction of shark nets around a number of bathing bays in Queensland, 158 dugongs were caught between 1964 and 1971. The Magnetic Island population was almost completely destroyed in one year. This exemplifies the effect which gill nets can have on this species throughout its range. Marsh et al (1984) estimate more than 1 000 dugongs may be taken accidentally in inshore and estuarine gill net fisheries for barramundi and thread-fin bream in northern Australian waters.

There is almost no information on the feeding habits of species of marine mammal in this area, and so it is difficult to relate marine mammal feeding to fisheries in this area.

There are six species of baleen whale known to occur in this area, but almost nothing is known of baleen whale feeding in the tropics, if indeed there is any; Bryde's whale is the possible exception. Leatherwood et al (1983) report seeing one individual eating mackerel near Sri Lanka, and presumably fish may be eaten in this area also.

Of the 24 other marine mammals listed above, 6 are beaked whales which are generally presumed to feed on squid, as are pilot whales and sperm whales. Dugongs consume sea grasses, and the finless porpoise is said to eat shrimps and prawns as well as small squid and fish (Leatherwood and Reeves 1983). Leatherwood et al (1983) suggest that Irrawaddy dolphins eat catfish.

The diets of the remaining 14 species are conjectural.

THE FISH STOCKS OF AREA 71

DEMERSAL FISH RESOURCES

The total recorded demersal catch was just over 0.5 million tonnes, but as Gulland (1983) points out, catches may be under-reported especially in scattered rural communities fishing in the coastal zone. The coastal and shallow water stocks are probably heavily fished, especially off densely inhabited coasts, but many deepwater stocks are probably still only lightly fished. The total catch is made up of a very great number of species, most of which are grouped by genus or family in any fishery statistics. Most fishing in the area is small-scale with a few trawlers, notably in the Gulf of Thailand (Gulland 1983).

Gulland (1983) states that there is a broad similarity in the species composition of the catch throughout the area. In the Gulf of Thailand this consists of 200-300 or more species (Tiews 1973). The demersal community consists of a number of small species, 'trash fish', a variety of intermediate sized species, and larger predatory fish, which fetch higher prices. Gulland (1983) amongst others has noted the change in species composition which results when such communities are heavily fished.

LEIOGNATHIDAE

Slipmouths and ponyfish, these are amongst the smallest of the commercially caught non trash fish. They feed on small bottom dwelling invertebrates in shallow water. Reported catches have been relatively stable at around 100 000 tonnes for at least six years

throughout area 71. In the Gulf of Thailand, however, the introduction of a trawl fishery in the 1960's lead to a shift in species composition, in which the total catch of these species declined dramatically (Ritragsa 1974).

Other medium sized fish include the threadfin breams Nemipteridae, monocle bream Scolopsis, and red mullets Mullidae, all of which feed mostly on bottom dwelling invertebrates and are prey for larger fish. Reported catches of these 3 groups totalled about 90 000 tonnes in 1981 (FAO 1983).

The larger, predatory, fish include snappers and groupers which fetch higher prices than the smaller fish, and may be caught by selective means, such as hand lines (Gulland et al 1974).

Many of the stocks of demersal fish may be over exploited at present (Gulland 1983) but there are considerable difficulties associated with assessment, notably the problems arising from catches with hundreds of species. Gulland suggests that some of the deeper water stocks are under-exploited, but are out of reach of inshore fishermen. The use of trawlers is not always possible in such situations, when competition with small scale fishermen arises. For this reason Indonesia has banned trawling in her waters (Keppres No. 3/1980 and Inpres 11/1982 : Indonesia Times 14.8.1982).

The effects of exploitation of demersal fish stocks, especially the effects of species changes, are difficult enough to assess. The problem of trying to assess the extent of interactions between marine mammals and fisheries would seem intractible in this region at present, not least because of the lack of data on marine mammal feeding.

PELAGIC FISH RESOURCES

The catch in 1981 of all pelagic species is recorded as just under 2.5 million tonnes. Once again, there is a problem of species identification. Some stocks may already be heavily fished, whilst others could sustain substantially greater catches.

Sardinellas, Decapterus species and Indian mackerels (Rastrelliger spp.) are all important components of the pelagic catch, each group yielding more than 200 000 tonnes in 1981.

Other important species include tunas which, taken together, yield catches in excess of 500 000 tonnes in this region.

Again, there are difficulties involved in trying to assess potential interactions between marine mammals and fish stocks when the diets of marine mammals are unknown, and when stock assessments are also problematic. Gulland (1983) suggests that some of the mackerel stocks are over-exploited, whilst many of the scad (Decapterus spp.) stocks may yield greater catches.

INVERTEBRATE RESOURCES

CRUSTACEA

Shrimps and prawns play a large role in the fishing economics of most nations in this area. In Indonesia banana prawns (Penaeus merguiensis) accounted for 54 000 million rupiahs in 1979, more than twice the value of any other species (Indonesia, Fishery Statistics 1981).

The fisheries for crustacea are conducted both by trawl and by a variety of other artisanal gears. The state of the stocks is not clear, but in general they may be fully exploited already (Gulland et al 1974). The implications of this for marine mammals such as Neophocaena are also unclear.

CEPHALOPODS

The total cephalopod catches in 1981 were about 150 000 tonnes in 1981 (FAO 1983), but there does not appear to be any published estimate of the cephalopod potential of this area.

THE FISHERIES OF AREA 71

According to Gulland (1983) these are chiefly artisanal, with the notable exception of the Gulf of Thailand trawl fishery. Artisanal gear includes a variety of local seine nets, as well as the more usual hand lines, beach seines, shrimp nets, lift nets and a variety of traps.

Artisanal fisheries are chiefly confined to a narrow coastal strip, up to 12 miles from land. This area is also the zone of highest fish density, and where larger vessels occur, they too tend to fish close in to the shore, where stocks are densest. This leaves a very uneven distribution of effort, implying an uneven pattern of exploitation.

For offshore marine mammals this uneven distribution of fishing effort may be advantageous, with less interaction, operational or biological, than might be expected if the fishing effort were more evenly spread out. Inshore, coastal or neritic species of marine mammal however, would seem to be more likely to conflict with fisheries. Not only would a zone of heavy fishing, mostly with artisanal gear, imply a large number of by-catches of marine mammals, but the local depletion of fish stocks mentioned by Gulland (1983) could also bring such coastal species into a situation of 'biological conflict', through reduced prey biomass.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 71

All the fishery interactions reported in this area are operational in nature, which is perhaps not surprising in an area which is one of the 4 most productive fishery areas in the world (Gulland 1983), where almost all fishing is performed by small scale coastal fisheries.

Operational interactions

1 A long-range gill net fishery off northern Australia, catching mackerel, sharks and tuna is known to take a by-catch of small cetaceans of 46 identified individuals. 36 were Tursiops truncatus, 6 were Stenella longirostris, 3 were S. attenuata and 1 was Pseudorca crassidens. The total number of small cetaceans taken in this fishery is estimated at more than 2 000 per year. (Harwood et al 1983).

2 Sivasubramanian (1964) has claimed that killer whales damage tuna longlines and catch throughout the area.

3 Shark nets in Queensland take a number of species including dugongs, bottlenose dolphins, Irrawaddy dolphins, humpback dolphins and at least one false killer whale (Bannister 1977).

4 Gill nets in northern Java are known to take some finless porpoises (Tas'an and Leatherwood 1983).

5 One bottlenose dolphin has been reported netted accidentally in Sulawesi.

Biological interactions

None are reported, although in the coastal zone, where many fish stocks are heavily exploited, some degree of overlap in prey species might be expected.

3.14 AREA 17: EASTERN CENTRAL PACIFIC

MARINE MAMMALS FOUND IN AREA 77

Eubalaena glacialis Right whale
The report of the Right Whale Workshop (IWC SC/35/Rep 2 1983) indicates that right whales are known along the west coast of North America as far south as Baja California, with one record from Hawaii. The calving sites in this region are unknown, as is the population size, but this is presumably now no more than a few hundred. There are no apparent indications of conflicts with fisheries, but net entanglements are always possible, and could have significant consequences.

Eschrictius robustus Grey whale
The eastern Pacific stock of this species is estimated to number around 16 000 (Rice et al 1981). Rice and co-authors suggest that this is close to the virgin population size. The diet has been studied by Zimusko and Ivashin (1980). No commercial species are consumed in area 77. Wolman and Rice (1979) have suggested that increased boat traffic may threaten the breeding population, and Miller et al (1983) record 3 killed in 1980 in gill nets in California, with 3-5 gill nets being destroyed by grey whales every year.

Balaenoptera physalus Fin whale
Berzin and Vladmirov (1981) have given an estimate of 14-19 000 fin whales for the North Pacific. The number of fin whales in area 77 is unknown, but there do not appear to be any reports of interactions with fisheries, except for one record of a possible entanglement in a Californian drift net for shark (Miller et al 1983).

Balaenoptera musculus Blue whale
The population size in area 77 is unknown, but Berzin and Vladimirov's (1981) estimate of 1 400 to 1 900 for the whole North Pacific implies that the population may not exceed the hundreds here. There do not appear to be any interactions with fisheries reported.

Balaenoptera acutorostrata Minke whale
There appear to be no population estimates for minke whale stocks in this area, nor any data relating to feeding. Interactions with fisheries seem unlikely and do not appear to have been reported.

Balaenoptera borealis Sei whale
Gambell (1977) records population estimates of this species, which is said to have had an exploitable population size of about 8 000 animals in 1967 in the eastern North Pacific. This might suggest a total population size at present of less than or around 15 000 animals. Nemoto and Kawamura (1977) suggest that the main diet item in the North Pacific is copepods, with fish forming 3.4% of the diet in this area. This would suggest very little interaction with fisheries, and there are apparently no records of such.

Balaenoptera edeni Bryde's whale
There do not appear to be any population estimates of this species in area 77, but Ohsumi (1977) has suggested a population in excess of 9 000 animals for the waters of the North Pacific east of 150°E. The diet in the eastern tropical Pacific does not appear to have been studied, but might be expected to include shoaling fish, such as sardines, as well as shoaling crustacea. There do not appear to be any recorded interactions with fisheries.

Megaptera novaeangliae Humpback whale
Catches of this species have been recorded by Townsend (1935) along the coast of Mexico and Baja California, and the species is known to breed in these waters, and around Hawaii (Tomilin 1967). There seem to be no reliable population estimates for area 77, but the population is presumably in the thousands. Feeding is generally confined to colder waters (Mackintosh 1965), and there appear to be no interactions with fisheries in this area.

Berardius bairdii Baird's beaked whale
The range of this species is known to extend as far south as southern California in the eastern North Pacific. The number of animals which move into this area is unknown, and

the diet is presumably squid here as elsewhere. There do not appear to be any records of interactions with fisheries.

Mesoplodon densirostris Blainville's beaked whale
Galbreath (1963) records this species from Midway Island, and it is generally assumed to range throughout tropical and warm temperate waters (Mitchell 1975). There are no population assessments, nor any data on feeding for this area. Interactions with fisheries seem unlikely.

Mesoplodon hectori Hector's beaked whale
Leatherwood and Reeves (1983) report one record of this species from California. Interactions with fisheries seem unlikely.

Mesoplodon ginkgodens Ginkgo-toothed beaked whale
Leatherwood and Reeves (1983) state that only one specimen has been found in this area, at Del Mas in California. There are no detailed data on abundance or feeding, but the species may be more common in area 61. Interactions with fisheries seem unlikely.

Mesoplodon carlhubbsi Hubb's beaked whale
Leatherwood and Reeves (1983) state that this species is recorded from as far south as San Diego, California; as with the previous species, no detailed data are available, but Leatherwood and Reeves suggest its range is broader in the eastern Pacific than in the western. Interactions with fisheries seem unlikely.

Ziphius cavirostris Cuvier's beaked whale
Orr (1948) records this species from California and Galbreath (1963) from Midway Island. There are no detailed data on diet or abundance in this area, and no obvious reference to any interactons with fisheries, which would seem unlikely.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps show a continuous and year round distribution of this species extending from off the coast of Ecuador along the equator, with smaller concentrations off Baja California. Although there are no estimates of the size of the population in area 77, Rice (1977) estimated the population size within 10 degrees of the equator from 80 to 110°W to be around 80 000 by sightings cruise. There are no apparent indications of interactions with fisheries.

Kogia breviceps Pygmy sperm whale
Recorded from Washington State to California (Leatherwood and Reeves 1983), this species does not appear to be very numerous in this area, or elsewhere. A few strandings have been reported. No detailed data on feeding are available for this area and interactions with fisheries seem unlikely.

Kogia simus Dwarf sperm whale
Leatherwood and Reeves (1983) record this species in this area only from central and Baja California. As with the previous species, this is apparently uncommon, and unlikely to interact with fisheries to any great extent.

Steno bredanensis Rough-toothed dolphin
Recorded from California and the Galapagos Islands (Hershkovitz 1966), Perrin and Watkin (1975) found fish and molluscs in the stomachs of some animals. Rough-toothed dolphins are known to be taken occasionally in the tuna seine fishery in the Eastern Tropical Pacific : the size of the population involved in this fishery has been estimated at 450 (IWC 1978 annexe E). It is not clear how this relates to the entire population in area 77, but Berzin (1978) states "Steno bredanensis is universally considered rare", so that the entire population in area 77 could number in the thousands. Despite its apparent rarity, this species is reported to remove bait (Decapterus sp.) from longlines in Hawaii fishing for tuna, marlin and shark (Mate 1980).

Peponocephala electra Melon-headed whale
Rarely recorded in the Eastern Tropical Pacific tuna fishery as an incidental capture (Perrin 1976), there are no population estimates of this species in area 77, and no other indications of interactions with fisheries.

Feresa attenuata Pygmy killer whale
This species has also been recorded rarely in tuna nets of the Eastern Tropical Pacific (Mitchell 1975); it is generally considered a rare species, but there are no abundance data and no information on the diet of this species in area 77. There do not appear to be any other interactions with fisheries.

Pseudorca crassidens False killer whale
Perrin and Oliver (1982) record one incidental capture in tuna purse seining operations. Mitchell (1975) cites unpublished data by Nishiwaki of 30-50 individuals taken accidentally in tuna longline fisheries "in the Pacific", and also states that false killer whales damage fish on longlines worldwide. Mate (1980) also reports that fishermen in Hawaii have claimed this species may take tuna from longlines there. There are no population estimates for this species in area 77. Perryman and Foster (1980) report that this species is known to feed on dolphins in this area, as well as on fish and squid.

Orcinus orca Killer whale
Dahlheim et al (1983) found that strandings of this species in and around area 77 were uncommon, with only 11 such records. Sightings were frequent in some areas, and 581 unpublished sightings records were found. The authors state that the diet of killer whales in their study area was unknown. There do not appear to be any records of interactions with fisheries.

Globicephala macrorhynchus Short-finned pilot whale
Pilot whales are reported by Donovan (1983) to have been commonly seen during research cruises through the southern parts of area 77. There do not appear to be any detailed data on diet, but Perryman and Foster (1980) report that this species is know to chase dolphins occasionally. This species is known to be included occasionally in the tuna purse seine fishery, an estimate of this population size having been given as 60 000 (IWC 1978 annexe E). De Master et al (1984 in press) also state that it may conflict with a Californian squid fishery for squid, and Miller et al (1983) report that up to 30 may be killed in each of the squid and shark gill net fisheries. Miller et al (1983) also report pilot whales scaring squid away from fishermen's nets, but were unable to quantify this.

Lagenorhynchus obliquidens Pacific white-sided dolphin
Recorded as far south as Baja California (Mitchell 1975), the diet of this species is known to include hake, anchovies and squid (Fitch and Brownell 1968). There are no detailed data on abundance, but the main area of distribution lies outside area 77. There seem to be no reports of conflicts with fisheries, though the diet might indicate some competition.

Lagenodelphis hosei Fraser's dolphin
Once thought to be extremely rare, data from other areas suggests this species may not be uncommon. Perrin et al (1973a) recorded 3 in a tuna net in area 77, and one population estimate based on such captures suggested a size of 7 800 for the population involved with this fishery. (IWC 1978 annexe E). Jackson (1980) reports about 60 of this species spotted during aerial surveys of the Eastern Tropical Pacific. There appear to be no data on the diet of this species in area 77.

Tursiops truncatus Bottlenose dolphin
This species is apparently abundant in this area as in other warm water regions. Some individuals are known to become trapped in tuna nets; Allen and Goldsmith (1981) estimate the number of mortalities from this source to be about 9 per year; the size of the population involved has been estimated as around 588 000 (IWC 1978 annexe E). Leatherwood and Reeves (1982) cite Iverson, and Shallenberger, in stating that this species also steals fish from longlines in Hawaii and steals skipjack tuna and damages gear in trolling and jigging fisheries in Hawaii. Mate (1980) also refers to bottlenose dolphins taking bait from handline fisheries for bottom fish in Hawaii. Leatherwood and Reeves (1982) also mention that as many as 50 animals a year may die in shark and sea bass gill netting fisheries in the Gulf of California, primarily near San Felipe, Mexico. There appears to be little data on the diet in this area.

Grampus griseus Risso's dolphin
Found throughout tropical and temperate seas (Mitchell 1975), Leatherwood et al (1980) describe the movements and distribution of this species, which they state occurs up to around 50°N, with greatest abundance near Monterey Bay in California. This species is evidently occasionally trapped in tuna nets, a population of 7 500 having been estimated to be involved in this fishery (IWC 1978 annexe E). The diet is presumed to consist largely of squid.

Stenella longirostris Spinner dolphin
Perrin (1975) has described 3 separate populations in this area, all of which are involved to some extent in the tuna seine fishery. Perrin (1969) describes the tuna fishery in the Eastern Tropical Pacific, in which fishermen set their nets around schools of dolphins as these are known to associate with tuna. By using the dolphins as a marker, fishermen locate the tuna school, but in the process of catching tuna, some dolphins are also killed as they become entangled in the netting. A population of more than 1.8 million spinner dolphins may be associated with this fishery in the Eastern Tropical Pacific. Hammond and Kao-Tsai (1983) have estimated that between about 7 and 9 000 spinner dolphins were taken in the tuna fishery in 1981; this is considerably less than the numbers in the late 1960's which may have been in the hundreds of thousands, so the stocks are presumably recovering after some depletion. Perrin and Henderson (1979) suggested that, at that time, the eastern spinner population was between 38% and 83% of its original size. Perrin et al (1973a) have found mesopelagic fish and epipelagic and mesopelagic squids in the diet of this species in this area.

Stenella coeruleoalba Striped dolphin
This species has not been so heavily affected as other Stenella species by the tuna fishery. In 1981 only around 60 are estimated to have been caught (Hammond and Kao-Tsai 1983). The population level has been estimated at around 250 000 animals (IWC 1978 annexe E). Miyazaki et al (1973) found mainly mesopelagic fish in the stomachs of this species in Japan.

Stenella attenuata Spotted dolphin
These are the dolphins most heavily affected by the tuna fishery, as described by Perrin (1969). In 1981 between 24 and 33 000 animals are estimated to have drowned in tuna nets (Hammond and Kao-Tsai 1983). The populations were estimated in 1978 to number more than 3.5 million animals; in 1979 the offshore stocks were estimated to be between 34% and 55% of their 1959 level (NMFS LJ-79-41 1979). Presumably stocks are at present recovering. The diet in this area is thought to consist of epipelagic fish such as flying fish, and squids (Perrin et al 1973).

Delphinus delphis Common dolphin
Another species which is partly involved with the tuna fishery, around 1,400 animals are estimated to have been killed in seine nets in 1981 (Hammond and Kao-Tsai 1983). The population size in 1978 was estimated to be around 1.5 million animals in total for the Eastern Tropical Pacific. Presumably such catch rates have little effect on the population; the 'central tropical stock' has been estimated to be between 86% and 100% of its 1959 value, when it became involved with the fishery (NMFS LJ-79-41 1979). The diet of this species does not appear to have been studied in any great detail in area 77.

Lissodelphis borealis Northern right whale dolphin
Mitchell (1975) states that this species occurs as far south as northern Baja California. There seem to be no data on abundance in this area, but this is presumably not a particularly common species in the warmer waters of this area. The diet is thought to include squid and myctophids. There are no apparent interactions with fisheries in this area.

Phocoena phocoena Harbour porpoise
Gaskin et al (1974) describe this species as occurring as far south as San Pedro in California, which would suggest that this is not a particularly numerous species in area 77. Gaskin (1983) suggests that the population in Monterey Bay may be around 600, and states that on the western U.S. seaboard about 20 are killed per year due to illegal sport shooting and incidental captures. The diet consists of a great number of species, and includes commercial species such as mackerel clupeids and gadoids. Some overlap with commercial fisheries would seem likely in this area as elsewhere, although this has not

yet apparently led to any conflict

Phocoena sinus Cochito
Brownell (1983) reviews the information on this species, stating that it is probably limited to the upper part of the Gulf of California, from where a total of about 30 confirmed records have been reported. This appears to be the only indication of abundance, and Brownell points out that this species is listed as vulnerable by the IUCN's Red Data Book. The diet is reported to include striped grunts (Orthopristis reddingi) and gulf croakers (Bairdiella icistius), as well as some squid. Brownell describes incidental captures of this species, suggesting that prior to 1975 a number of porpoises, possibly in the range of tens to hundreds, were taken in a commercial gill net fishery for shark and totoaba. This fishery was officially closed in 1975, but Brownell suggests that incidental captures may persist in gill net fisheries for other sciaenids and sharks, and in shrimp trawl fisheries, the combined effects of which may represent a substantial impact on a localised and relatively small population.

Phocoenoides dalli Dall's porpoise
Mitchell (1975) states that this species ranges as far south as central Baja California. The population size in area 77 is unknown, but the main area of distribution lies to the north. The diet in this area is known to include hake (Merluccius productus), squids (including Loligo opalescens) and horse mackerel (Scheffer, cited in Wilke and Nicholson 1958). There do not appear to be any recorded interactions with fisheries, although some amount of competition would seem to be expected.

Eumatopias jubatus Steller sea lion
Mate (1982a) describes the distribution and status of this species, the total population of which, in Californian waters, he states may be stable, at around 5 000 to 7 000, although in some (southerly) areas, it may be declining. Fiscus and Baines (1966) have studied the diet of this species which includes flatfishes and rockfishes in this area. Although Mate (1982a) refers to conflicts with fisheries, these do not appear to be important in area 77. Nevertheless, the diet suggests some overlap with commercial fisheries for prey items.

Zalophus californianus Californian sea lion
Mate (1982) describes the status and distribution of this species. The range extends from Canada to Mexico, with a subspecies (Z.c. wollebaeki) breeding in the Galapagos Islands. The Californian population was heavily exploited last century, but is currently either stable or growing, numbering around 7 500 - 100 000 animals. 20 000 animals are thought to breed on the Galapagos. Mate suggests the diet includes squid, various rockfish, Clupea and other small fish including Engraulis and Merluccius, but that the extent of competition with fisheries for food is unclear. Protection of the sea lion in an area which is heavily fished has led to a great number of operational interactions between fishermen and this species. De Master et al (1984 in press) have summarised the situation in California, where this species and the harbour seal are said to do most damage to gear and catch. The salmon trolling fishery is said to have lost more than $130 000 in May 1980, not including damage to gear; sea lions have learned to follow boats and remove hooked fish. Losses to other salmon fisheries may be around $17 000. Sea lions also interfere with river gill net fisheries and sport fisheries, where losses of catch may be worth around $700 000. Gill and trammel net ocean fisheries are also affected, and De Master and co-authors estimate a loss here of around $80 000. Sea lions are known to become entangled in such gear and may cause considerable financial loss by damaging nets in this fishery as well as catch. Herring are also known to be taken from a number of herring fisheries. Miller et al (1983) estimate that in U.S. waters an annual total of around $380 000 is lost in fish and gear in salmon fisheries, and about $120 000 in gill net fisheries, nearly all of which is attributable to sea lions. They also estimate around 1 900 sea lions die each year as a result of fishing activities.

Callorhinus ursinus Northern fur seal
The most southerly breeding colony of this species is at San Miguel Island off California; the population there numbers around 2 000 animals (Gentry 1981), which may be roughly the number present in area 77 for most of the year. Kajimura (1984 in press) states that the main food items in Californian waters are anchovy, Engraulis mordax, Pacific whiting, Merluccius productus, the market squid Loligo opalescens, and in lesser

quantities, Pacific saury, Cololabis saira, jack mackerel, Trachurus symmetricus, rockfishes, sablefish and oceanic squid. The diet suggests some competitive overlap with commercial species, but as yet little conflict has been reported in this area, presumably as the population is very small, especially when compared with other local mammal species.

Arctocephalus townsendi Guadaloupe fur seal
The population is severely depleted and confined to areas around Baja California. There do not appear to be any interactions with fisheries. (see species account also).

Arctocephalus galapagoensis Galapagos fur seal
The population is severely reduced, but may now number around 5 000 (Clark 1979). The diet consists of cephalopods. Interactions with fisheries seem unlikely, as the Galapagos Islands are a reserve.

Phoca vitulina Harbour seal
Occurring as far south as Baja California (Bonner 1979c), Bigg (1981) suggests around 40 000 animals are present from British Columbia to Baja California. Food species commonly eaten include herring, anchovy and rockfish (Bigg 1981). De Master et al (1984 in press) state that this species causes considerable damage to fisheries in California. Harbour seals are responsible for removing salmon from gill nets, where some individuals become entangled, and are known to remove herring from a variety of gear types. Miller et al (1983) estimate that around 200 are killed in California every year, in ocean gill net fisheries, and in the Klamath river subsistence gill net fishery for salmon. They also estimate that around $74 000 worth of fish are damaged in this latter fishery every year.

Monachus schauinslandi Hawaiian monk seal
Kenyon (1981) describes this species. The population is thought to be in danger, and may be declining, with current numbers totalling less than 700 animals. The diet is said to include lobsters, eels, flatfish, scorpaenids and octopus. Kenyon suggests that some gear interactions may occur and contribute to the decline of this species. Some individuals have been observed with scars similar to those caused by netting in other species. Other individuals have been observed tangling themselves in fishing gear, and Kenyon gives one undocumented case of an animal dying in a fish trap.

Mirounga augustirostris Northern elephant seal
Breeding sites of this species are confined to area 77, from Baja California, on offshore islands, to the Farallon Islands, due west of San Francisco. The population may total nearly 50 000 and is expanding after depletion last century (McGinnis and Schusterman 1981). McGinnis and Schusterman cite Huey's (1930) feeding data for this species, which included ratfish, dogfish, shark, puffer, skates and squid, all deepwater species. The only example of interaction with fisheries at present appears to be the entanglement a small number of this species in gill and trammel nets in ocean fisheries (Miller 1981).

At least 10 of the 42 species listed above consume some commercial species, or may be assumed to do so, and a further 8 or 9 are presumed to eat squid for the most part. 7 species of baleen whale may not feed very much in the area, and the diets of the remaining 16 species are unclear.

THE FISH STOCKS OF AREA 77

DEMERSAL FISH RESOURCES

The demersal finfish potential in this area has been estimated at around 1 million tonnes (FAO 1981); the commercial catch in 1981 totalled around 50 000 tonnes (FAO 1983).

The U.S. sports fishery presumably takes a large catch also, but figures for this are not available. The shelf in this region is not very wide, so that productivity of demersal resources is not high; neither is there a very large number of species listed amongst the demersal catch.

SCORPAENIDAE

The largest single group in terms of catch is the scorpionfish. Catches in 1981 totalled 10 297 tonnes. Although such fish are known to be eaten by a number of pinniped species, there does not appear to be much interaction.

No other group of demersal finfish yeilded catches in excess of 8 000 tonnes, suggesting that demersal fisheries in this area are not very important. Ainley et al (1982) refer to the closure of the whiting fishery off California in 1977 under the Fishery Conservation and Management Act of 1976. They relate this to changes in the distribution and feeding behaviour of California sea lions. Currently (1981) whiting, or hake (Merluccius productus), catches are negligible in this region, though this stock is harvested further north. Kajimura (1984 in press) also relates the importance of this species to the Northern fur seal population in Californian waters.

PELAGIC FISH RESOURCES

The total potential of the pelagic resources of this area, excluding tuna, has been estimated at between 2 and 2.5 million tonnes (FAO 1981). The catch in 1981 was over 2 million tonnes, including tuna, which accounted for 300 000 tonnes (FAO 1983). The estimated potential and current yield would appear then to be in reasonable agreement at present, suggesting that the resources as a whole may be close to full exploitation.

Engraulis mordax
The North Pacific anchovy is distributed mainly in coastal waters from Baja California to Washington. Catches in 1981 totalled 424 000 tonnes, whereas the potential may lie between 500 000 and 1 million tonnes. Kajimura (1984 in press) states that this species is the most abundant and largest fishery resource in the California current system. This is also said to be one of the main food species for Northern fur seals, and is eaten by harbour seals and sea lions, and probably by a number of small cetacean species also. Gulland (1983) has also pointed out the importance of this fish resource both as a food supply for larger fish, and as a bait supply for sport fishermen.

Sardinops caerulea
The Californian sardine fishery was once one of the most important in the Pacific, with catches of up to 800 000 tonnes, but has since declined especially in the northern part of its range to a fraction of this; catches in 1981 were around 345 000, almost entirely off Mexico (FAO 1983). Although Kajimura (1984 in press) does not list this as a food species in Northern fur seals, possibly as the main distribution of this fish species is currently around Baja California, this would seem to be a likely prey species for a number of other marine mammals.

Cololabis saira
The Pacific saury ranges throughout the North Pacific, and is one of the most abundant fish in the area (Kajimura 1984 in press). This would seem likely to play an important role in the feeding of certain marine mammals, including some of the oceanic dolphins, and Kajimura (1984 in press) has affirmed its importance in the diet of the Northern fur seal.

Salmon
Although not a very large fishery in this area (1 688 MT in 1981), there are some serious gear interactions between Californian sea lions and harbour seals on the one hand, and a number of salmon fisheries, including troll and gill net fisheries on the other. Miller et al (1983) estimate nearly $300 000 worth of fish are removed from fishermen's nets and lines per year, mosty by Californian sea lions.

Tuna
Although not important as a food fish for marine mammals, tuna are nevertheless probably the most important fishery in economic terms for the whole area. More than 300 000 tonnes of all species were landed in 1981 (FAO 1983). In the central Pacific tuna longliners operate, mostly from eastern Asia. The American and Mexican fleets are mostly purse seiners, and it is these vessels which have become involved in the controversy over

the incidental capture of small cetaceans. The current incidental take is only around 30-40 000 per year (Hammond and Kao-Tsai 1983), but in the late 1960's hundreds of thousands of animals were killed every year.

Other important fish species of the area include jack mackerel (Trachurus symmetricus) which has an estimated potential yield of 300 000 tonnes, but a current catch of only 15 000 tonnes, and which is among the leading forage species of the fur seal; jack mackerels would also seem likely to be important in the diet of other marine mammals, as they are both abundant and schooling. In more southerly areas of area 77, thread herring (640,000 tonnes in 1981) and anchoveta (110,000 tonnes caught in 1981) are evidently important fish stocks, but there is little data on marine mammal feeding on these species.

INVERTEBRATE RESOURCES

CRUSTACEANS

Over one hundred thousand tonnes of various shrimp and crab species were landed in 1981 from this area. Gulland (1983) states that this is the main fishery in tropical areas. Offshore, shrimp trawlers operate, whilst in the coastal areas, artisanal methods predominate. There seems to be little reported interaction between these fisheries and marine mammals.

CEPHALOPODS

More than 30 000 tonnes of cephalopods were reported caught in this area in 1981 (FAO 1983), an increase from only 10 000 tonnes in 1976. This is a productive area, however, in which Voss (1973) states, "undoubtedly a large resource is waiting to be tapped"; the total potential is unknown, but jumbo squids (Dosidiscus gigas) alone may have a potential of more than 1 million tonnes (FAO 1981a).

THE FISHERIES OF AREA 77

The fisheries of this area are dominated by Mexico, which in 1981 took 1.2 million tonnes of a total catch of 2.6 million tonnes. The USA took 354 000 tonnes, Ecuador 686 000 tonnes and Panama 132 000 tonnes. Japan was the principle foreign nation represented in the 1981 catch statistics by a catch of 86 000 tonnes. Mexican catches in particular have increased dramatically from 286 000 tonnes in 1972.

The main fisheries in this area are undoubtedly the pelagic ones. Mexico's catches of sardines and anchovies have increased from 40 000 tonnes in 1970 to over 400 000 tonnes in 1979 (Gulland 1983), and pelagic fish dominate the landings statistics.

Gulland (1983) states that the main U.S. interest in fisheries is in tuna seining. Other fisheries in California are also important, however, and De Master et al (1984) and Miller et al (1983) have reviewed their relation to marine mammals. Further south shrimp trawling and pelagic fisheries for thread herring, anchoveta and mackerel are all important, down to Ecuador. Demersal fish are lacking, although Gulland states that more of these are caught than appear in the statistics, as there is considerable by-catch in shrimp trawling. The sport fishery cannot be ignored in this respect either, with large catches being taken particularly in Californian waters, though no statistics on these are available. Small scale fisheries are clearly important along much of the central and south American coasts, as well as in Central Pacific islands, but there is very little information on interactions between marine mammals and those fisheries, beyond some records of bait-stealing from longlines and handlines in Hawaii.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 77

The reported interactions between marine mammals and fisheries in this area are most notable in that they are heavily concentrated in two areas, around California and in the offshore tuna fishery operations. This almost certainly represents a heavy bias in the reporting rather than in the numbers of interactions.

Operational interactions

1 The most significant interaction is undoubtedly that of the U.S. tuna purse seine fishery which annually takes up to 40 000 small cetaceans. Most of these are spotted and spinner dolphins of the genus Stenella but small numbers of a range of other species are also taken incidentally. The number of porpoises killed in the tuna fishery has been greatly reduced by changes in the gear (e.g. addition of special panels in the nets) and in the way it is operated which allow marine mammals to escape much more easily after the net has been closed. These are also large year to year changes in the kill rate, depending on the pattern of fishing, and the proportion of sets made on porpoises, in the expectation that there are tuna underneath, compared with direct sets on school fish.

2 Californian salmon fisheries, troll and gill net, are seriously affected by sea lion depradation, and in the Klamath River at least, by harbour seal damage also.

3 Californian coastal and oceanic gill net fisheries suffer from heavy depredation at times, mostly by Californian sea lions, and to a lesser extent harbour seals. Northern elephant seals and pilot whales are also implicated in damaging nets and frightening off squid respectively.

4 The cochito was known to become trapped in gill nets in the northern Gulf of California, and although the main fishery involved in this interaction has been stopped, there are some suggestions that the population may still be threatened by such entanglements, although data is sparse.

5 Hawaiian monk seal numbers appear to be declining, and there is some suggestion that entanglement in fishing gear may play a part in this.

6 Other miscellaneous gear interactions involve the bottlenose and rough-toothed dolphins, which steal fish from line fisheries in Hawaii. The former is also subject to some net entanglement in Mexican waters, and there is some reported entanglement of the harbour porpoise also. Grey whales and possibly fin whales, may also be entangled occasionally in gill nets in U.S. waters

It would seem likely that incidental captures occur all down the American coast, but there is very little published information concerning the fisheries of the more southerly areas.

Biological interactions

Marine mammal species in northern parts of area 77 appear to be free from very much competition with fisheries. Stocks of anchovy, Pacific whiting and Pacific saury are all either under-exploited by fisheries, or not fished at all. These species are important in the diets of pinnipeds at least, and as they are all abundant in the area, are presumably available to cetaceans which feed on small schooling fish such as Bryde's whale, common dolphins and possibly other species too.

Squid resources are also under exploited, but throughout the region, and so presumably little competition occurs between squid fisheries and squid eating marine mammals.

It is interesting to speculate upon what effect the reduction of sardine and mackerel stocks in this area might have had on feeding behaviour of any marine mammals feeding on these species in former years. It is also interesting to ponder the possible effects of an expansion of fisheries onto those stocks already mentioned, which appear at present to be under-exploited. Data on the possible competitive interaction between marine mammals and fisheries are lacking for much of the rest of area 77.

Although strictly outside the scope of this report, it is worth noting in passing the considerable conflict which has arisen between the sea otter (Enhydra lutris) and U.S. shell fisheries. A number of studies have been made of the diet and feeding behaviour of sea otters, and their impact on fisheries, particularly for clams and abalone. The report of the IUCN workshop on Marine Mammal/Fishery Interactions (IUCN 1981) discusses

some of the findings. Sea otters, whilst eating commercially valuable shellfish, also eat sea urchins. In areas without sea otters, urchins graze kelp beds, whereas where sea otters are present, the kelp beds flourish, to the benefit of a number of commercial fish species which use kelp beds as refuges prior to recruitment. The sea otter may therefore be both benefactor to and competitor with commercial fishermen.

3.15 AREA 81: SOUTHWEST PACIFIC

MARINE MAMMALS FOUND IN AREA 81

Eubalaena glacialis Right whale
The Report of the IWC's Sub Committee on Protected Species and Aboriginal Whaling (IWC 1983) indicates that 264 right whales were sighted in the 1981/2 sightings programme, mostly around Campbell Island (53°S). Not all of these were necessarily different whales. The population size in this area is unknown but unlikely to exceed a few hundred. No interactions with fisheries are recorded.

Caperea marginata Pygmy right whale
Baker (1972) states that this species is rare in New Zealand waters, with only 12 having stranded until that date. No interactions with fisheries would seem likely.

Balaenoptera physalus Fin whale
The population size in area 81 is unknown. Area 81 covers the IWC's Antarctic areas VI and parts of I and V, for which there are some baleen whale population estimates, but it is not possible to say how these stocks distribute themselves in the Sub-Antarctic and temperate waters of area 81. A population of more than a few tens of thousands would seem unlikely. Interactions with fisheries also seem unlikely.

Balaenoptera musculus Blue whale
The population size is again unknown, but is unlikely to exceed a few thousand. Interactions with fisheries are unknown.

Balaenoptera acutorostrata Minke whale
There are no reliable estimates for this species in the area, but presumably the population size is no more than a few hundred thousand at most. There are no records of minke whales eating commercial species in area 81.

Balaenoptera borealis Sei whale
The population in area 81 is unlikely to exceed a few thousand, and no interactions with fisheries are likely.

Balaenoptera edeni Bryde's whale
There are no reported interactions with fisheries, but as this whales is known to eat commercial fish species in similar latitudes, it would seem possible that some competition for prey species could occur. The population size is unknown, but Baker (1972) states that they are fairly common north of East Cape in New Zealand.

Megaptera novaeangliae Humpback whale
Humpback whales are well known as migrants from the Antarctic to breeding sites around New Zealand and Tonga as Townsend's (1935) maps demonstrate. The population size is unknown but is severely depleted and may number in the hundreds at present. Baker (1972) states that 500 were seen in Cook Strait in 1953, but that only 23 were seen in 1963. Feeding in this area is not known and there are no indications of interactions with fisheries at present, although Baker states that this whale frequents the coastal waters of New Zealand, where there is presumably some risk of gear interaction.

Tasmacetus shepherdi Shepherd's beaked whale
Recorded only from a few strandings, the population size is unknown, and nothing much is known of the diet, though squid might be expected to play a major role in this. No interactions with fisheries seem likely.

Berardius arnuxii Arnoux's beaked whale
Baker (1972) records 19 strandings in New Zealand until that date; the population is of unknown size but evidently may not be very large. The diet is presumed to include squid; interactions with fisheries would seem unlikely.

Mesoplodon densirostris Blainville's beaked whale
Watson (1981) gives a record of this species from Lord Howe Island in the Tasman Sea, but this species is said to be confined to tropical and warm temperate waters (Marcuzzi and Pilleri 1971). There is no indication of population size in area 81, and interactions with fisheries seem unlikely.

Mesoplodon layardii Strap-toothed whale
Baker (1972) states that more than 20 of these whales have stranded in New Zealand. Their abundance and diet are not known. No interactions with fisheries seem likely.

Mesoplodon hectori Hector's beaked whale
Baker (1972) describes this as a rare species, there are no data on feeding, and interactions with fisheries seem unlikely.

Mesoplodon grayi Gray's beaked whale
Baker (1972) describes this species as a regular strander on New Zealand beaches, so it is evidently not too uncommon in those waters. The diet is unknown, and there seems little likelihood of interactions with fisheries.

Mesoplodon bowdoini Andrew's beaked whale
Baker (1972) describes this species as rare in New Zealand, which is one of the few places it has stranded. Nothing is known of the diet, which, as for all beaked whales may be assumed to include squid (Gaskin 1982). Interactions with fisheries seem unlikely.

Ziphius cavirostris Cuvier's beaked whale
Numerous strandings of this species are known from New Zealand (Baker 1972), so it is evidently not too uncommon. Little is known of the diet in these waters, but this presumably includes squid and deepwater fish as elsewhere. No interactions with fisheries would seem likely.

Hyperoodon planifrons Southern bottlenose whale
Although Mitchell (1975) describes this species as widespread throughout its range, Baker (1972) suggests that it is rare in New Zealand. The diet is thought to include squid, and no interactions with fisheries are known.

Physeter macrocephalus Sperm whale
Townsend's (1935) maps show a distribution of this species to the north of New Zealand in winter, and more densely through the Tasman Sea and around New Zealand in summer. Baker (1972) also states that this species is more frequently found around New Zealand in summer. The population size in area 81 is unknown, but may be in the hundreds of thousands, in summer at least. There are no apparent interactions with fisheries, and these seem unlikey.

Kogia breviceps
Baker (1972) states that at that time 23 of this species had stranded on New Zealand. He also states that they consume squids, shrimps, crabs and fish. There are no apparent interactions with fisheries and these seem unlikely

Pseudorca crassidens False killer whale
At least 3 mass stranding of this species have occurred in New Zealand waters (Baker 1972). There are no apparent population estimates nor records of interactions with fisheries for this area specifically. In other areas this species is said to cause problems with tuna longlining operations, and it is possible that such problems exist in area 81, where tuna are the most important catches in terms of weight.

Orcinus orca Killer whale
Baker (1972) describes this as a common species around New Zealand where it feeds on

seals and dolphins as well as squid and fish. There appear to be no more detailed data than these on the diet of the killer whale in area 81. The population size is also unknown, but may be in the tens of thousands. The New Zealand Progress Report to the IWC in 1980 (IWC 1981) records one Orcinus found dead due to gear injury. Operational interactions are also known in the dropline fishery off eastern Tasmania, referred to in the Australian Progress Report of the same year (IWC 1981), in which killer whales take up to 30% of the fish on a dropline. It is not clear whether this fishery operates in area 81 or 57. Killer whales, like false killer whales, have been known to harass tuna longline fisheries also, and may be presumed likely to be involved in such interactions in this area as elsewhere, although there appears to be no record of this.

Globicephala melaena Long-finned pilot whale
Baker (1972) refers to many strandings of this species in New Zealand, and although there are no population estimates, this would seem to be a relatively common species. There do not appear to be any data on the diet of this species in area 81, but the pilot whale is known to consume squid in other areas (Sergeant 1962). The New Zealand Progress Report to the IWC in 1981 (IWC 1982) refers to one pilot whale caught in a set gill net off the New Zealand coast. This appears to be the only record of any interaction with fisheries in area 81, and if this reflects the scale of incidental capture, it can have little effect on the pilot whale population.

Lagenorhynchus obscurus Dusky dolphin
Baker (1972) suggests that this coastal species is fairly common in New Zealand from Hawke Bay, south to Fiordland. There do not appear to be any feeding data for this species in area 81, but some are evidently taken in fish nets. The New Zealand Progress Report to the IWC in 1981 (IWC 1982) states that incidental captures have been observed but not reported in two South Island set gill net fisheries. In one of these, in which gill nets are set to depths of up to 370 metres, about 120-150 dolphins are estimated to have been taken per year, of which the dusky dolphin was the principle species. The report continues :"L. obscurus is particularly abundant in this area and there is no evidence as yet that these incidental catches are having any effect on the stock".

Lagenorhynchus cruciger Hourglass dolphin
Baker (1972) states that this is a coldwater oceanic species found south of New Zealand, occasionally straggling north to New Zealand. There do not appear to be any abundance estimates nor feeding data for area 81 and this species is not so far recorded in any interactions with fisheries.

Tursiops truncatus Bottlenose dolphin
Baker (1972) describes this species as common in New Zealand waters, and Mitchell (1975) records its incidental capture in midwater trawls around New Zealand, where he suggests, hundreds may be taken per year. There do not appear to be any detailed data on the diet, and so nothing can be said about the likelihood of competition with local fisheries.

Grampus griseus Risso's dolphin
Baker (1972) states that this species is rarely found in the south Pacific, with only 4 records from New Zealand. The diet is elsewhere thought to consist of squid, and no interactions with fisheries have been recorded.

Stenella coeruleoalba Striped dolphin
There seem to be no reports of interactions between this species and fisheries in area 81, nor any data on feeding or abundance though individuals are said to come near to New Zealand occasionally in summer (Baker 1972).

Delphinus delphis Common dolphin
Said to frequent New Zealand coastal waters, often in schools of several thousand (Baker 1972), the population is clearly considerable. There do not appear to be any detailed feeding data in this area, but this species is often caught accidentally in nets around New Zealand. Progress Reports to the IWC from New Zealand list 9 animals killed in pair trawls, 2 in single trawls and 5 in gill nets in the Bay of Plenty in 1978. In 1979 11 were reported killed in pair trawls, 12 in single trawls, and 1 in a crayfish pot line (IWC 1981). Other incidental captures reported include two fouled in a rock lobster pot line in 1980, 2 in purse seines in 1980, 1 in a single bottom trawl in 1980, 9 in purse

seines in 1981 and 2 in set gill nets in 1981. In addition an unspecified number (less than 120) were taken in deep set nets, together with some other species from 1980-81 (IWC 1982). The effects of all of this mortality on the common dolphin population are unknown, but if the actual numbers killed are not very much in excess of this, it would seem unlikely that the population is being depleted. Competitive interactions with fisheries cannot be assessed at this stage.

Lissodelphis peronii Southern right whale dolphin
An oceanic species found in the south of this area, there are no obvious data on abundance or feeding in this area, and no by-catches have been reported to the IWC.

Cephalorhynchus hectori Hector's dolphin
Baker (1978) describes this species. It is found in inshore waters (out to 8km), often in muddy water, all around New Zealand. The food is said to include Trachurus novaezelandiae, Physiculus bachus (red cod) and Crepatalus novaezelandiae (stargazer). Engraulid otoliths have also been found in samples; the implied diet is of pelagic and benthic fish below the surf zone. Baker states that about 11 are caught incidentally per year in gill net fisheries for elephant fish, and in bottom trawls too; he also states that there is no evidence of a decline in the population. The New Zealand Progress Report to the IWC in 1981 (IWC 1982) supplies records of Hector's dolphins caught incidentally in 1980/81; 1 was reported in a set gill net off Waiheke Island, an estimated 6 are thought to have died in set gill nets on South Island, and an unspecified number (less that 120) in another deep set net fishery off South Island.

Phocoena dioptrica Spectacled porpoise
Baker (1977) records this species from Enderby Island in the New Zealand Sub-Antarctic. It is presumably rare and interactions with fisheries would not seem likely.

Phocarctos hookeri Hooker's sea lion
Warneke (1982) states that the main population is centered on several of the small islands of the Auckland group rather than on the mainland. Other breeding groups occur at Campbell Island, the Snares and at Stewart Island. Stragglers are said to occur as far north as the Otago Peninsular in South Island, and at Macquarie Island in the south. Warneke estimates the population at around 4 000. Walker and Ling (1981) summarise the data on feeding, food items including squids and octopuses, small fish, including flounder, and crabs, mussels, penguins and other sea birds.

In recent years Soviet and Japanese joint venture squid fisheries have opened up around the Auckland Islands. These are said to last for 2 months of the year and involve about 15 boats taking 30 000 tonnes of squid. The fishery is said to take a by-catch of females feeding after paturition (Mike Donahue, pers. com.). The number of casualties are unknown, but for such a small population, the loss of these females could be important. The amount of competition with fisheries, for prey species, has not been analysed.

Arctocephalus pusillus doriferus Australian fur seal
Breeding occurs from seal rocks in New South Wales (area 81) to Southern Tasmania and Victoria (area 57), the diet is said to consist mainly of squid and octopus, as well as a wide variety of fish such as barracouta (Thyrsites) and sometimes whiting (Sillaginodes), flathead (Platycephalus), red mullet (Upeneichthys), parrot fish (Pseudolabrus), leather jackets (Aluteridae) and small fishes such as pilchards (Clupeidae), (Warneke 1982). The population size is thought to be around 20 000, most of which breed in area 57 (Warneke 1982). Marlow (1967) stated that at that time many individuals were killed illegally by fishermen either for crayfish bait or for their supposed competition for fish of commercial value. Warneke (1982) states that significant numbers of immatures are lost by accidental drowning in nets and rock lobster traps and by shooting. Warneke (1982) adds that although it is widely claimed by fishermen that fur seals damage fish stocks, such claims have not been substantiated by evidence from fisheries statistics or the contents of stomachs, or ejecta.

Arctocephalus forsteri New Zealand fur seal
Breeding occurs at many sites on South Island, and on a number of offshore and Sub-Antarctic Islands, which are described by Crawley and Warneke (1979) in detail. Crawley and Warneke also provide a population estimate of around 38 500. Bonner (1981) sum-

marizes information on the diet which is thought to consist mostly of octopus (Octopus maorum), squid (Notodarus sloanii and Sepioteuthis bilineata) and barracouta (Thyrsites atun). Other minor items include penguins. Crawley and Warneke (1979) state that some accidental drownings in net and rock lobster fisheries probably occur. With respect to biological interactions, whilst Bonner (1981) suggests that fur seals are often accused of damaging fish harvests, especially in New Zealand, he also states that the amount of commercial fish consumed is less than might appear to fishermen who may observe the seals with large fish, which they are forced to come to the surface to eat. Warneke (1982) suggests that commercial fish are incidental in the diet and adds elsewhere that the population is expanding. An expanding population of pinnipeds may still be seen as a threat by fishermen anywhere.

Mirounga leonina Elephant seal
About 100 000 elephant seals are said to breed on Macquarie and the New Zealand Sub-Antarctic islands (Laws 1979). Warneke (1982) states that the feeding habits in this area have not been studied in detail, though fish, small crustaceans and cephalopods may all be important. Warneke adds that stragglers are found on New Zealand and Australian shores, where they may eventually recolonize former breeding sites, which were occupied before the advent of commercial sealing operations. There do not appear to be any interactions with fisheries in this area at present.

Hydrurga leptonyx Leopard seal
Marlow (1967) states that during spring some individuals wander northward from Antarctic waters to Macquarie Island and as far as the Australian mainland. The numbers involved probably constitute very little risk of interaction with fisheries.

Leptonychotes weddelli Weddell seal
Marlow (1967) and De Master (1979) confirm that this species occasionally wanders as far north as Australia and New Zealand. Presumably this species too is not numerous enough in area 81 for any significant interactions with fisheries.

The diet of most of the species occurring in this area are poorly known in detail. What is known seems to suggest that squid is very important as a food source. Of the 36 species listed above 7 species of baleen whale probably consume only pelagic crustacea (see Nemoto 1959 eg) and one may consume some fish (Bryde's whale). Squids are thought to be important in all the beaked whales diets as well as the diets of a number of the other small cetaceans and pinnipeds.

Of the remaining species little is known of the diets, and there are no substantiated suggestions of any species consuming large amounts of commercial fish, as yet.

THE FISH STOCKS OF AREA 81

The total biological potential of this region has not yet been surveyed. A number of stocks, however, in coastal areas have been assessed.

DEMERSAL FISH RESOURCES

Demersal stocks in area 81 include not only the demersal fish of New South Wales and New Zealand, but also the resources of a number of island states in warmer waters. Catches in 1981 amounted to only around 160 000 tonnes.

GADIFORMES

A few species of this group are found in New Zealand and other waters. The southern poutassou, Micromesistius australis, has an estimated potential of 50 000 tonnes off the south of New Zealand (FAO 1981), but catches amounted to only 6 632 tonnes in 1981 (FAO 1983). Similarly, grenadiers may have a potential of 10 000 tonnes, though only 3 000 were taken in 1981 (FAO 1983).

Chrysophrys aurata Golden snapper
Stocks in Victoria and New South Wales provided catches in 1981 amounting to 13 000 tonnes.

Arripis trutta Australian salmon/ruff
A total of 3 412 tonnes of this species were taken in 1981; this is one of the very few commercial species where any interaction with marine mammals is recorded. (The Australian sea lion is said to annoy salmon fishermen by attacking the nets to get at salmon in area 57 (Warneke 1982)).

Very few demersal species are listed in the fishery statistics yearbook. Other species which may be locally important include snappers and groupers off reefs in some of the Pacific islands, and other reef fish. There seems to be no report, however, of any interactions between marine mammals and such fish stocks in these islands.

PELAGIC FISH RESOURCES

The total pelagic resource potential for the southwest Pacific has been estimated at 1 million tonnes, but this includes the area off southern Australia and Tasmania which is actually in area 57, and excludes a large part of area 81 to the west. This latter region is mostly open ocean, which is not likely to be very productive (Rhyther 1969). The total pelagic catches in area 81 amounted to around 140 000 tonnes in 1981 (FAO 1983). Clearly these resources, like the demersal ones are, taken as a whole, under-exploited.

Tuna
A glance at the Yearbook of Fisheries Statistics (FAO 1983) reveals that tuna and tuna like fishes form by far the largest group of catches in this area. Catches in 1981 were around 65 000 tonnes, or over half of the total pelagic catch. Several different species are caught; most tuna fishing in the area is by longline, although there are some long-established local live-bait fisheries, and purse seining is beginning to develop (Gulland 1983). Longlining, however, may involve other forms of conflict, with killer whales, or false killer whales (see above).

Other stocks include some sprat and pilchard around New Zealand and Australia, which at present appear to be almost entirely unfished. These could be food supplies for a number of species including common dolphins and Bryde's whales but there are no data on this. Snoek or barracouta (Thyrsites atun) yielded around 2 700 tonnes in 1981 (FAO 1983), and is known to be eaten by a number of pinnipeds; this is not thought to present any particular problem as yet, although fur seals have been known to disrupt line fishing for this species. Mullet (Mugilidae) occur around the coasts of New Zealand and Australia. Catches are only of the order of 3 - 4 000 tonnes, but these species are elsewhere known to be eaten by the bottlenose dolphin (see area 37,34).

INVERTEBRATE RESOURCES

CRUSTACEA

Under 8 000 tonnes of crustaceans were taken from these waters in 1981, most of which, 4 500 tonnes, were rock lobsters. Stocks of these species are described as being the most economically important in the region and are fully exploited. Although known to be eaten occasionally by fur seals (Warneke 1982), this does not seem to be a major area of conflict. Several species of marine mammals are known to become entangled in pot lines and lobster traps.

CEPHALOPODS

Cephalopods are said to be common in this area (Gulland 1983), although there appears to be little local fishing for them. Gulland states that a Japanese squid fishery operates off the northwest coast of South Island, and reference has been made to another foreign

fishery off the Auckland Islands (see Arctocephalus forsteri above). The catch statistics for area 81 reveal that a some 60 000 tonnes of squids were caught in 1981 in this area (FAO 1983). Voss (1973) states that the potential may be several hundred thousand tonnes. The implications of this in relation to interactions with marine mammals are unknown, but many species present in the area feed on cephalopods.

THE FISHERIES OF AREA 81

Gulland (1983) states that until recently few Australian or New Zealand boats were longer than 15 to 20 metres, but that recently larger boats have been added to the fleets for deepwater trawling, and purse seining. Local fisheries have been very varied and have included trawl fisheries in coastal waters, beach seining and lobster fishing. Larger boats are mostly from the USSR and Japan, which trawl for grenadiers, poutassou, barracouta and jack mackerel. Longlining for tuna also appears to be important throughout the area, including warmer waters, where island fisheries are chiefly confined to small scale artisanal forms, using a variety of gear.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 81

Operational interactions

Operational interactions are most fully documented, in the case of cetaceans, in the Progress Reports of Australia and New Zealand to the International Whaling Commission. There are no large scale incidental captures, and the main conflicts seem to arise in the case of pinnipeds which, in this area as elsewhere, annoy fishermen by taking fish from nets.

1 Bannister (1977) states that most kills of small cetaceans are "due to fishermen shooting dolphins because of their real or assumed interference with fishing operations". There are no data on this.

2 Bannister also mentions a small number of small cetaceans, possibly one every two years, that are killed in New South Wales shark nets.

3 The New Zealand Progress Reports to the IWC have listed a number of species which have been reported as incidental captures. The species involved are pilot whale(s), dusky dolphins, killer whale, common dolphins and hector's dolphin, as well as an unidentified baleen whale, and an unidentified beaked whale. The gears involved are purse seines, trawls, set gill nets, and crayfish pot lines. The most frequent mortalities appear to involve set gill nets and dusky dolphins.

4 Pinnipeds are also recorded as having drowned in nets and lobster traps, and as annoying fishermen by damaging both nets and catch. Both species of fur seals are known to become involved in such interactions.

5 Hooker sea lions are said to be taken in significant numbers by a squid fishery in the Auckland Island region.

6 Considering the amount of tuna longlining which occurs in this area, it would be surprising if either the killer or false killer whale were not involved in some conflict with this fishery, although this does not seem to have been recorded yet.

Biological interactions

The diets of most of the species in this area are too poorly known for any assessment of the extent of any biological interaction. The exceptions are the diets of the pinnipeds.

Both species of fur seal are apparently thought of as competitors by fishermen, as are, from the report by Bannister (1977), small cetaceans in Australia. The data on fur seal feeding reveal that they are unlikely to be competing to any great extent with fishermen. The data on small cetaceans are not complete enough for any such parallel analysis. The

potential interaction between squid fisheries and marine mammals should not be ignored in this area where many of the species, including some of the rarest species of marine mammals, feed largely on squid. The fact that at least one marine mammal population is known to be increasing, in an area where fisheries are still relatively undeveloped, should also give some cause for thought about the possible future interactions.

3.16 AREA 87: SOUTHEAST PACIFIC

MARINE MAMMALS FOUND IN AREA 87

Eubalaena glacialis Right whale
There are no population estimates of this species in area 87. The Report of the Right Whale Workshop (SC/35/Rep 2 1983) lists the maximum number of right whales seen in any one day as 2. Clearly the population is small whilst recovering from commercial whaling, and may number no more than a few hundred. There are no recorded interactions with fisheries. Net entanglements have been recorded in other areas, and if they occur here could affect the population recovery.

(Caperea marginata Pygmy right whale
Although this species does not seem to have been recorded in this area, Ross et al (1975) describe its distribution as circumpolar in all southern oceans).

Balaenoptera physalus Fin whale
The Peruvian Progress Report to the IWC in 1982 (IWC 1983), reports 2 fin whales seen off the Peruvian coast in 1981/82. There appears to be no more detailed description of abundance than this. The stock must be presumed small, after depletion by commerical whaling and may number no more than a few thousands. There appear to be no detailed data on feeding nor any reports of interactions with fisheries in area 87.

Balaenoptera musculus Blue whale
The Peruvian Progress Report to the IWC in 1982 (IWC 1983) lists 644 blue whales sighted in 1981 and 622 in 1982. There are no population assessments for area 87, nor any records of interactions with fisheries. The population however, seems unlikely to be more than a few hundred.

Balaenoptera acutorostrata Minke whale
Although there are no population estimates for area 87, this species is known to occur in all southern oceans and a population of at least a few tens of thousands might be expected. There are no apparent records of interactions with fisheries.

Balaenoptera borealis Sei whale
There are no reliable estimates of the population size of sei whales in area 87, but a population in the thousands might be expected. There are no records of interactions with fisheries, and none would seem likely.

Balaenoptera edeni Bryde's whale
Estimates have ranged from 11 316 to 8 571 (IWC 1981 Annexe F) for a total population size of the stock fished off Peru. Cooke (1983) has criticized these estimates as being too high. The population is depleted at present due to commercial whaling. There appear to be no data on feeding in this area nor any records of interactions with fisheries, but some overlap with commercial fisheries for prey species might be expected.

Megaptera novaeangliae Humpback whale
A total of 37 humpbacks were sighted in the 1981/82 season (Peru Prog Rep : IWC 1983). There are no population estimates, but this stock presumably numbers in the hundreds rather than the thousands. There are no indications of any interactions with fisheries, although this species, like the right whale, is known to frequent inshore waters, exposing it to a risk of gear entanglement.

Tasmacetus shepherdi Shepherd's beaked whale
Leatherwood and Reeves (1983) refer to one record from Chile, which appears to be the only record from area 87. The species must be regarded as rare, and although commercial

fish were found in the stomach of an animal in Argentina (Mead and Payne 1975), extensive interactions with fisheries are unlikely.

Berardius arnuxii Arnoux's beaked whale
Leatherwood and Reeves (1983) describe the distribution of this species in all southern oceans up to about 30°S. There seem to be no detailed data on abundance or diet, nor any records of interactions with fisheries, but this does not seem to be a common species.

Mesoplodon layardii Strap-toothed whale
Leatherwood and Reeves (1983) describe the distribution of this species as similar to the previous one. There appear to be no detailed data from area 87; this is another rare species, and interactions with fisheries seem unlikely.

(Mesoplodon grayi Gray's beaked whale
There do not appear to be any records of this species in area 87, but Leatherwood and Reeves (1983) suggest a circumpolar distribution in southern waters. There are no indications of interactions with fisheries).

Ziphius cavirostris Cuvier's beaked whale
Mitchell (1975a) describes this species as occurring in all oceans. There appear to be no detailed data on diet nor abundance in this area, although it does not appear to be very abundant anywhere. There are no records of interactions with fisheries in this area.

Hyperoodon planifrons Southern bottlenose whale
Mitchell (1975) describes this species as widespread in all southern oceans. There appear to be no detailed data on feeding or abundance, and no indications of interactions with fisheries.

Physeter macrocephalus Sperm whale
Peruvian Progress Reports to the IWC indicate that between 1.8 and 3.4 thousand sperm whales have been sighted off Peru for the past 7 years. The population size is unknown, but may be in the tens of thousands. There are no records of interactions with fisheries.

Kogia breviceps Pygmy sperm whale
Leatherwood and Reeves (1983) refer to a stranding in Peru, but there is no detailed information for this area. Interactions with fisheries seem unlikely.

(Kogia simus Dwarf sperm whale
Not yet recorded from this area, Watson (1981) amongst others believes the distribution is throughout all oceans).

Feresa attenuata Pygmy killer whale
There appear to be no records of this species in area 87, but the distribution is thought to include all tropical and temperate waters (Mitchell 1975).

Psuedorca crassidens False killer whale
There seem to be no detailed data for this area, and no records of interactions with fisheries. The possibility of conflict with tuna longliners as in other areas, should be borne in mind.

Orcinus orca Killer whale
There does not appear to be any detailed data on the feeding of this species in area 87, nor any indication of abundance. Some interaction with fisheries might be expected but does not appear to have been reported.

Globicephala melaena Long-finned pilot whale
Aguayo (1975) refers to this as one of the most abundant species on the Chilean coast. There do not seem to be any detailed data on feeding nor records of interactions with fisheries.

Lagenorhynchus obscurus Dusky dolphin
Mitchell (1975a) states that a few of this species are taken in catches of porpoises off western South America, but there appear to be no data on abundance, numbers of this species caught, nor on the diet.

Lagenorhynchus cruciger Hourglass dolphin
Leatherwood and Reeves (1983) state that this species has been sighted as far north as 34°S off the South American coast, but AguaYo (1975) does not record it from Chile. It is presumably uncommon, in coastal waters at least, and prefers cooler waters. There are no indications of likely interactions with fisheries.

Lagenorhynchus australis Peale's dolphin
Aguayo (1975) records this species from 32° to 60°S. There seem to be no detailed data on abundance or feeding, but Goodall and Cameron (1980) state that it is taken for baiting traps for southern king crab. They state that the actual numberS involved are unknown but suggest these may be in the thousands. The effect that this may be having on the population is unknown.

Tursiops truncatus Bottlenose dolphin
Aguayo (1975) provides records of this species in Chilean waters where it is apparently not uncommon. Aguayo (1975) also states that some are taken incidentally by small boat fishermen, but gives no figures. There do not appear to be any data on feeding for this species in area 87.

Grampus griseus Risso's dolphin
Aguayo (1975) records this species in Chilean waters, and Leatherwood and Reeves (1983) state that it ranges as far south as central Chile. There are no detailed data on feeding for area 87, and no apparent records of interactions with fisheries.

Stenella longirostris Spinner dolphin
Although this species is known to occur in all warm tropical waters, there seems to be a paucity of records from area 87. The influence of the Peru coastal current may exclude this species from all but the northern end of area 87, in the coastal area at least. There are no apparent records of abundance in this area nor of any interactions with fisheries.

Stenella attenuata Spotted dolphins
Spotted dolphins are also presumably confined to the warmer northerly regions of area 87; there are no apparent data on abundance nor indications of interactions with fisheries.

Lissodelphis peronii Southern rightwhale dolphin
Aguayo (1975) describes the distribution of this species in Chile from around 19°S to Cape Horn, suggesting that it may be quite common in some areas, even in coastal regions. Aguayo also records the accidental capture of one specimen on a hook and line; presumably others are also caught incidentally, but there are no figures on such captures.

Delphinus delphis Common dolphin
Aguayo (1975) describes the distribution of this species in Chilean waters as extending from around 29° - 41°S, where it appears to be quite common. Although incidental captures might be expected, there do not appear to be any such records.

Cephalorhynchus eutropia Black dolphin
Aguayo (1975) describes this species as rare, with a distribution along the Chilean coast from around 35°S to 60°S. Goodall and Cameron (1980) mention that this species is caught incidentally along the Chilean coast in surface gill nets but no figures are available.

Cephalorhynchus commersonii Commerson's dolphin
Records from the southern end of South America are summarized by Aguayo (1975). There appear to be no detailed data on the feeding habits, nor on abundance. Goodall and Cameron (1980) report that an unknown number of this species, at least 30 a year, are accidentally captured in crab nets in Chilean Tierra del Fuego. They also describe the use of this species, together with Peale's dolphin, as crab bait in Chilean Tierra del

Fuego. They suggest that thousands of animals (of both species) may be taken every year, but there are no data on this.

Phocoena spinipinnis Burmeister's porpoise
Brownell and Praderi (1982) describe this species throughout its range, and describe it as the most abundant small cetacean in coastal waters around southern South America. They describe reported incidental captures in small boat fisheries in Peru. Although the type of gear involved and the species of fish are not stated, Brownell and Praderi suggests that at least 2 000 animals are taken per year. The effect of this mortality on the population is not known.

Otaria flavescens South American sea lion
Occurring on the Pacific coast of South America from Cape Horn to the Galapagos, and to 4°S on the Peruvian coast (Vaz-Ferreira 1982). Vaz-Ferreira has given estimates of the population in this area suggesting a minimum of 40 000 animals in the area, although not all of it has been surveyed.

Vaz-Ferreira states that "sea lions are decimated by human agency including regular exploitation, clandestine exploitation, and killing by fishermen on account of damage to nets; and a reduction in population is the rule over most of its area of distribution". Data on feeding is summarized by Vaz-Ferreira, and in Chile is known to include 'cabrilla' Sebastodes oculatus, 'merluza' Merluccius gayii, 'sardina' Clupea bentinckii as well as some molluscs and crustaceans. Birds are also known to be eaten, inluding penguins. Vaz-Ferreira concludes that "competition of sea lions with man for food resources is evident,... but no estimation of the total competition can be worked out with the scanty data available", and also mentions that direct interference with fisheries is well known, involving the severe damage of fishing tackle and removal of fish. Recently, the Diario Oficial De La Republica De Chile (11 July 1983) modified decree 4844 in order to include the sea lion as a pest species which may be shot.

Arctocephalus philippii Juan Fernandez fur seal
Confined to a few islands off the coast of Chile, the species was presumed extinct until 1965 (Bonner 1981), after a period of heavy exploitation (Aguayo 1979). Aguayo states that up to 750 seals have been counted, and that there is some illegal killing by fishermen, who may use them for lobster bait. There are no detailed data on feeding.

Arctocephalus australis South American fur seal
Vaz-Ferreira (1982a) states that the population on the western coast of South America is distributed from the Paracas Peninsular in southern Peru to Cape Horn, and may number in excess of 50 000 animals, the population being either stable or diminishing. There do not appear to be any detailed data on diet from this area, but various fish, including anchovies, horse mackerel, weakfish, and invertebrates including cephalopods are said to be eaten in general. Although Vaz-Ferreira states that this species feeds over a wide area of the continental shelf and beyond, and causes no important damage to fisheries, he also cites Brownell as having examined 13 individuals which had drowned in trammel nets, and continues that there is perhaps some interference with fishing gear placed too close to the rookeries. There are no quantitive data on these interactions.

Leptonychotes weddelli Weddell seal
De Master (1979) states that this species has been sighted as far north as the Juan Fernandez Islands, but this is principally an Antarctic seal. There are no indications of the number of animals migrating into area 87, but these are presumably few. No interactions have been reported with fisheries, and none would seem likely.

The diets of most of the 38 species of marine mammals listed above are unknown in this region, as are the population sizes. Antarctic baleen whales are generally held (eg Mackintosh 1946) not to feed much in the northern or breeding end of their migratory routes. Bryde's whale presumably does feed, and given the abundance of anchovies and sardines in this area, it might be considered safe to suggest these as 2 items likely to occur in the diet.

At least 7 or 8 species mentioned above are generally held to feed on squid. These include all the beaked whales, the sperm whale and Risso's dolphin. It is interesting to speculate upon the diets of the remaining species, many of which are coastal species. Even the southern rightwhale dolphin, normally described as oceanic, is here, according to Aguayo (1975) found in the coastal zone.

THE FISH STOCKS OF AREA 87

The fish resources of this region are dominated by 2 or 3 pelagic species, but some demersal species too are caught in appreciable numbers. The reasons for the predominance of pelagic fish are that the shelf area along this coast is relatively narrow, but there are strong upwelling currents making the area very productive.

DEMERSAL FISH RESOURCES

The total demersal catch in 1981 was around 230,000 tonnes, 100,000 tonnes of which came from just one species. The stocks are probably fully exploited except in the southern part of Chile.

Merluccius gayi Chilean hake
The Chilean hake fishery is one of the few commercial fisheries for demersal fish in area 87. 104 000 tonnes were taken in 1981, a decline from over 380 000 tonnes in 1978 (FAO 1983). Sea lions are known to include this species in their diet but the extent of the competition is unclear.

Other demersal species which are caught in relatively large numbers include Patagonian hakes Merluccius polylepis and Patagonian grenadier Macruronus magellanicus, presumably these are also mainly trawled for.

Much of the fishing in this area is still apparently from small boats, and other species caught include a small range of groupers, snappers and drums, amongst other fish.

PELAGIC FISH RESOURCES

The pelagic fish stocks of this area are very large and have produced in good years over 10 million tonnes of fish, but there is considerable variation. Catches in 1981 for all pelagic species amounted to around 6.5 million tonnes.

Engraulis ringens Anchovy
The Anchoveta fishery was once the largest in the world in terms of weight, but having been severely overfished in the late 1960's and early 1970's, currently (1981) yielded only 1.5 million tonnes. Gulland (1983) describes the history of this fishery. It is interesting that, as Gulland notes, the sea bird population is said to have undergone a decline during the period of greatest anchovy catches, and these 2 events have been linked: the decline in bird numbers may have been related to a reduced food supply. This prompts the speculation as to what effects the fishery may have had on any marine mammal populations. Unfortunately not enough is known of the diets or population dynamics of marine mammal species in this area to answer this question. Both fish and bird stocks also seem sensitive to changes in the ocean environment, particularly the el Nino phenomenon.

Sardinops sagax
As in other parts of the world, the decline of one fish stock seems to have lead to an increase in another and the collapse of the anchoveta has roughly coincided with a rise in the pilchard stock. The pilchard fishery in this region now exceeds the anchovy fishery and catches totalled 2.8 million tonnes in 1981 (FAO 1983).

Other important pelagic species include the Chilean jack mackerel Trachurus murphyi which yielded 1.6 million tonnes in 1981, and yellowfin tuna, which yielded over 100,000 tonnes.

INVERTEBRATE RESOURCES

CRUSTACEA

Crustacean resources are an important part of the fisheries of this area, and those species which are fished include squat lobsters (Galatheidae), lobsters and king crabs (Lithodes). This latter species is the most interesting in terms of marine mammals as it is this which is fished for off Tierra del Fuego, using tangle nets which entrap at least one marine mammal species (L. commersonii).

CEPHALOPODS

At present these resources appear to be greatly under-exploited with only a few hundred tonnes landed in 1981 (FAO 1983). The total potential may be around 500 000 tonnes (Voss 1973).

THE FISHERIES OF AREA 87

Gulland (1983) states that prior to the anchoveta fishery, the main fisheries of this area were the Peruvian bonito and Chilean hake (trawl) fisheries. Other fisheries in the area are mostly artisanal, using small boats and a variety of gear. The anchoveta fishery employs purse seines, which, after the collapse of the anchovy stocks are also used to fish for sardines and other species.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREA 87

Marine mammal fishery interactions in this area are not well documented, and although there is some evidence of a number of incidental captures, there are few data to show the extent of these.

1 Aguayo (1975) refers to a number of species taken in small boat fisheries along the Chilean coast. These include P. spinipinnis, L. obscurus, L. australis, Lissodelphis peronii and C. eutropia

2 Goodall and Cameron (1980) report that 2 species are taken for bait in Tierra del Fuego, L. australis and C. commersonii, and that C. commersoni may also be taken in crab nets.

3 Sea lions are known to be regarded as pests by fishermen throughout the area, as they damage nets and catch, having learned to follow fishing boats.

4 South American fur seals are taken, possibly in small numbers only, as an incidental catch in some fisheries.

5 Juan Fernandez fur seals may occasionally be taken by fishermen for bait.

Biological interactions

There are no documented examples of any effects of competition between marine mammals and fisheries in this area, although the collapse of the anchovy stock could well have affected some species, such as Bryde's whale.

Squid fishing appears to be of minor importance, though as elsewhere, any development of this fishery could lead to increased competition with marine mammals.

3.17 AREAS 48, 58 AND 88: SOUTHERN OCEANS.

MARINE MAMMALS FOUND IN AREAS 48, 58 AND 88

Eubalaena glacialis Right whale
The southern hemisphere population has been found mostly between 30° and 50° South, although Mackintosh (1965) states that right whales are known to range south of the Antarctic Convergence. The southern hemisphere population may number in the low thousands at present (Report of the Right Whale Workshop, IWC 1983), but the proportion of these which move into areas 48 58 and 88 is unknown. The food is principally copepods (Mackintosh 1965) and no interaction with fisheries is likely.

Balaenoptera physalus Fin whale
Migrating south during the austral summer, fin whales are distributed in their feeding grounds south of the Antarctic Convergence, as far south as about 60°S (Mackintosh 1965). The migration routes and feeding areas are more well documented than for many of the other species, as fin whales have a long history of commercial exploitation. Laws (1977) has suggested that the stock may have been reduced from around 400 000 animals initially to around 80 000 in the 1970's. Grenfell (1983) has estimated the total population in Antarctic areas 2, 3, and 5 (60°W to 70°E and 130°E to 170°W) to be around 80 000 also. The total population for the whole region could therefore exceed 100 000, but is still only a fraction of the initial population size. The food has been studied amongst others by Nemoto (1959, 1970) and in Antarctic waters is restricted to euphausiids, mostly the commercially caught E. superba, but also Thysanoessa macrura. There are no records of conflicts with fisheries, but Laws (1977) and Beddington and de la Mare (1984) have pointed out some of the possible interactions between recovering whale stocks and krill harvests.

Balaenoptera musculus Blue whale
Blue whales in the southern oceans are apparently less common than fin whales, but no satisfactory population estimate has been made. Laws (1977) gives a total figure of 6 000 for the whole region, and figure of 200 000 for the initial stock size. The diet consists mostly of Euphausia superba, although some other euphausiids are also taken (Nemoto 1959, 1970). Laws (1977) states that the blue whale feeds at high latitutes on first year krill.

Balaenoptera acutorostrata Minke whale
The smallest and currently most numerous of the Antarctic baleen whales, minke whales are found right up to the ice edge. The population has been estimated to number around 580 000 animals (IWC 1984), and is currently still hunted in Antarctic waters, around 6 000 being taken every year. Laws (1977) suggests that the minke whale population may actually be higher today than it was prior to commercial whaling in the region, as the reduction in stocks of other species has resulted in an increase in minke whales through reduced competition. Nemoto (1970) states that the diet of the minke whale in southern oceans is restricted to euphausiids. The fact that minke whales are more abundant near the ice edge compared with some of the larger species implies that it may be less likely to conflict with krill fisheries in the future, as these tend to operate further north.

Balaenoptera borealis Sei whale
Preferring warmer waters than fin and blue whales (Tomilin 1957), sei whales nevertheless penetrate into Antarctic regions; Mackintosh (1965) states that the extent of the geographical range is similar to blue and fin whales, although sei whales appear to favour warmer waters, and that their movements are less regular and predictable. The stock size has been estimated by Grenfell (1983) to have fallen from around 65 000 in 1904, before commercial whaling in Antarctic waters, to around 19 000, in areas 2, 3 and 4 (60° eastwards, to 130°E) at least. Laws (1977) suggests a decline overall, from around 75 000 to 40 000. Elsewhere the population has been estimated at between 15 and 30 000 in the southern hemisphere (IWC 1980). The diet, according to Nemoto (1979), includes not only euphausiids but also other swarming crustacea such as the amphipod Parathemisto.

Megaptera novaeangliae Humpback whale
Five or six seperate stocks are known to spend the austral summer in Antarctic waters, with little inter-mixing between the groups (Mackintosh 1965). The population is thought

to number a few thousand; Grenfell (1983) estimated that in Antarctic areas 2, 3 and 4 (60°W eastwards, to 130°E) the recruited stock numbered 4 670. Laws (1977) gives figures of 100 000 and 3 000 for total southern stock sizes before and after exploitation. Chittleborough (1965) states that Euphausia superba is the main food item, but that Thysanoessa macrura is also eaten. The latitudinal range of this species whilst in Antarctic waters falls somewhere between the fin and sei whales (Laws 1977).

Physeter macrocephalus Sperm whale
Sperm Whales migrate towards the poles in spring and summer, but it is thought that it is mainly the mature males which venture into Antarctic waters (Laws 1977). Stock estimates have been made for females for southern hemisphere sperm whale divisions (see appendix in IWC vols.) 2, 3, 4, and 6, and for males in divisions 2 to 7 by Cooke, de la Mare, and Beddington (1983). They estimate the total initial stock for these areas to have been in excess of 380 000 whereas the current stock size is estimated to be more than 235 000. The total population of such whales in Antarctic waters might therefore exceed 400 000. The diet is almost exclusively cephalopods (Laws 1977). Laws (1977) and Beddington and de la Mare (1984) have pointed out the possible ramifications of a change in the population of sperm whales, which as they feed higher up the Antarctic food chain, may have a more dramatic effect on the whole system through smaller population changes than would be necessary in baleen whales.

Berardius arnuxii Arnoux's beaked whale
Known from the Antarctic peninsula and the Subantarctic Islands of the Atlantic, this is a cephalopod eating species, with an unknown population size, but frequent strandings suggest that the species may be most abundant in the waters around New Zealand. (Leatherwood and Reeves 1983)

Hyperoodon planifrons Southern bottlenose whale
This species is not frequently observed, but is recorded from the Pacific, Indian and Atlantic Ocean Sectors of the Antarctic (Leatherwood and Reeves 1983). The diet consists of squid, and the population size is unknown.

Orcinus orca Killer whale
Occurring throughout the region, this species is found even in the polar ice floes. The diet is very varied, and in this area includes seals and cetaceans, as well as penguins (IWC 1982). The Antarctic population size may be around 160 000 (Hammond 1983). The only overlap with 'fisheries' is the killer whales predation on minke whales, which are also hunted in Antarctic waters, but this does not seem to have been isolated as problematic.

Lagenorhynchus cruciger Hourglass dolphin
A little known dolphin, with a distribution north and south of the Antarctic Convergence, there are no population estimates for this species (Leatherwood and Reeves 1983). Interactions with fisheries seem unlikely for the present.

Lissodelphis peronii Southern rightwhale dolphin
Described by Leatherwood and Reeves (1983) as a marginal Antarctic species, there are no population estimates for this area, although presumably the population is small. Food for this species is thought to include squid and non commercial fish, and interactions with fisheries seem unlikely.

Cephalorhynchus commersonii Commerson's dolphin
Brownell (1974) record this species at South Georgia (area 48) and at Kerguelen (area 58). The population status is unknown. Leatherwood and Reeves (1983) refer to krill crabs and cephalopods in the diet, but few data are available. Nothing is known of actual or potential interactions with fisheries.

Phocoena dioptrica Spectacled porpoise
Brownell (1974) records this species from area 48 around South Georgia and Leatherwood and Reeves (1983) from Kerguelen. The population size is unknown, as is the diet. Interactions with fisheries are therefore also unknown.

Arctocephalus gazella Antarctic fur seal
Distributed throughout the islands south of the Antarctic Convergence, the major breeding population is on South Georgia. Payne (1977) has studied the dynamics and structure of the fur seal population at South Georgia. At that time the population was estimated to be expanding at a rate of 16.8% per year. The population size was estimated at 369 000 in 1979 (Payne 1979 cited in Bonner 1981). Payne (1977) suggested that the rate of increase would decline possibly within a decade of 1977, and suggested that food availability may come into play as a regulating factor. The diet consists most of krill, although fish, squid and penguin remains have also been found (Bonner 1981). Recent reports (Anon 1984) have suggested pup survival has fallen markedly, with females spending up to 3 times as long searching for food. Although the report suggests overfishing of krill as the cause of this, the extreme variability of krill density, coupled with Payne's (1977) predictions concerning food supply, warn against too hasty a conclusion being drawn.

Arctocephlaus tropicalis Subantarctic fur seal
Although occasionally reported from South Georgia there are also colonies on Prince Edward and Marion Islands in the Southern Indian Ocean, and stragglers are reported from the Isles Crozets (Bonner 1981). The population size in areas 48, 58 and 88 is unknown, but the total population may number around 110,000 (Bonner 1981), and the centre of distribution is outside Antarctic waters. The diet is composed of squid, penguins, and euphausiid crustacea, but the distribution of this species is away from krill harvests, except around South Georgia.

Mirounga leonina Southern elephant seal
With breeding populations on Heard Island, Kerguelen, and through the Scotian Arc and South Georgia, much of the species distribution falls within areas 48 and 58. Individuals are also known from around the Antarctic continent, where there are a number of moulting areas (Ling and Bryden 1981). The population in these areas must at some times of year include much of the estimated total of about 580 000 individuals (Ling and Bryden 1981). The diet consists of squid and fish, and Ling and Bryden (1981) suggest that fish (mainly Notothenia spp) may be consumed in inshore waters, and cephalopods elsewhere. Pascal (1984 in press) has linked an apparent decline in the Kerguelen population with fishing for notothenids in the waters thereabouts, but McCann (1982) has disputed this idea. Clearly the potential for interaction exists where fishing for Notothenia occurs.

Lobodon carcinophagus Crabeater seal
Found throughout the Antarctic area, expecially in the pack ice, this is the most numerous of seal species with an estimated population size of 15 million (Laws 1977). The diet is mainly euphausiids, and although the distribution of this species, close to the ice (Kooyman 1981), may limit operational interactions with commercial fisheries, the size of the population and the amount of krill consumed may involve some competitive interaction with the krill fishery.

Ommatophoca rossi Ross seal
Ray (1981) states that this species is the least known of all seal species, and that it prefers the consolidated pack ice areas of Antarctica. Laws (1977) gives a population estimate of 220 000. Ray cites Oritsland (1977) for the food of this species, found to consist of 64% cephalopods, 14% other invertebrates including some krill, and 22% fish. No conflict with fisheries has yet been recorded.

Hydrurga leptonyx Leopard seal
Kooyman (1981) described this species as occuring throughout the pack ice, south to the Antarctic continent, and also on the Subantarctic Islands of South Georgia and Heard, mainly in winter. Population estimates have ranged from 100 000 to 300 000, and the diet is known to include a wide range of food organisms, including krill, penguins, seals, squid and fish (Kooyman 1981). There appear to be no records of interactions with fisheries.

Leptonychotes weddelli Weddell seal
Distributed most densely near the coast of Antarctica, breeding colonies occur as far north as South Georgia. The population size is unknown, but is believed to exceed 750 000, and the diet consists almost entirely of fish, especially Dissostichus mawsoni.

(Kooyman 1981). Interactions with fisheries are not known at present.

Of the 19 species of marine mammal inhabiting these waters, 8 are thought to feed entirely or mainly on krill, especially E. superba. 8 more feed wholly or in part on squid, and 2, the killer whale and leopard seal have very catholic diets, including other marine mammals. Fish play a relatively minor role in the diets of marine mammals in these areas, only the weddell seal being truly piscivorous. 3 or 4 other species do take some fish, notably the elephant seal.

THE FISH STOCKS OF AREAS 48 58 and 88.

The main pototential fishery resource in the southern oceans is a crustacean, Euphausia superba, rather than a fish. Fish are not numerous in the region when compared with the biomass of krill, but have nevertheless been heavily harvested. The slow growth of Antarctic species of fish means that the potential sustainable yield is not very large. Whales and seals have been important in Antarctic harvests in the past, but currently only minke whales are taken in any large numbers. Laws (1977) suggests that enormous depletion of whale biomass, which he estimates is now around 15% of that prior to commercial exploitation, may mean that there is at present a very large 'surplus' amount of krill production, which could be harvested, but much of which may be at present consumed by other species.

DEMERSAL FISH RESOURCES

NOTOTHENIIDAE

Catches of notothenids reached a peak of 400 000 tonnes in the 1970/71 season, taken mostly by the USSR in the waters around South Georgia, and crashed to almost nothing the next year (Gulland 1983). In the 1980/81 season over 63 000 tonnes were taken, again mostly in the Atlantic sector, although over 16 000 tonnes were taken in the Indian ocean sector. The total potential for Antarctic cods is not known, but Gulland (1983) suggests that they are very heavily fished.

CHANNICHTHYIDAE

Icefish were exploited after the boom and crash of the notothenids, again mostly in the Atlantic sector. Around 200 000 tonnes were taken in the 1977/78 season, but catches have dropped off in recent years to 40 000 tonnes in 1980/81 (FAO 1983). These stocks are also heavily fished.

INVERTEBRATE RESOURCES

CRUSTACEA

Krill represents an enormous resource in these areas, the total potential yield of which could be in the tens of millions of tonnes per year. At present, however, the catch is only in the hundreds of thousands of tonnes. In 1980/81 285 000 tonnes were taken in the Atlantic and 160 000 tonnes in the Indian Ocean sectors. Most of this was taken by the USSR. Even though only a fraction of the potential of this fishery has yet been realised, the 448 000 tonnes catch recorded for 1981 (FAO 1983) makes this the 25th largest single species fishery in the world. Beddington and de la Mare (1984) have pointed out that the extreme variability of oceanographic conditions in these waters is likely to produce big variations in local productivity and abundance of krill, which could be exacerbated by fisheries, which are likely to concentrate on areas of high productivity.

CEPHALOPODS

Very little exploitation has occured in Antarctic waters. Japan took 390 tonnes in area 88 in 1977/78, and none since then (FAO 1983). The productivity of the area and the large numbers of sperm whales and other squid eating animals in the area, indicates that

there is a potential for a much larger fishery.

THE FISHERIES OF AREAS 48, 58 AND 88.

Dominated by the USSR in all sectors, Japan, Poland and the German Democratic Republic also take some fish and krill from Antarctic waters. The fishery for krill employs large scale trawlers, which may be unlikely to suffer gear conflicts with marine mammals. Most fishing occurs in the Atlantic sector, around South Georgia and the Scotia Arc, where concentrations of krill are highest, with some fishing also around the Subantarctic Islands of the Indian Ocean sector. As yet interactions with marine mammals are minimal, but the recovering whale stocks, and the sheer size of the biomass of marine mammals in the area, which is largely dependent on a single species resource, clearly make future interactions with an expanded krill fishery potentially a very serious problem. This problem has been discussed by Beddington and de la Mare (1984), and is also one of the main considerations of the various scientific bodies which have been set up in recent years in order to provide a rational management plan for the southern oceans.

SUMMARY OF MARINE MAMMAL FISHERY INTERACTIONS IN AREAS 48, 58 AND 88

Unlike the other areas of the world's ocean, operational interactions appear to be rare or absent, probably due to the capital intensive and highly mechanised fishery which presumably has less chance of gear conflicts than numerous small vessels with other types of gear. The reported interactions so far involve two possible cases where fishing may have affected the life history parameters of a marine mammal. Firstly there has been some suggestion that krill harvests around South Georgia could be responsible for increased pup mortality in the Antarctic fur seal population (Anon 1984). Such suggestions remain unconfirmed at present (Anon 1984). Secondly, trawling for fish may have affected elephant seals on the Island of Kerguelen (Pascal 1984 in press). Future interactions might be expected with any or all krill eating mammals. Laws (1977) has pointed out the enormous potential 'surplus' of krill available since the decline of baleen whales, and Beddington and de la Mare (1977) have pointed out some of the problems associated with trying to exploit this krill resource.

4. CONCLUDING REMARKS

Throughout this report a distinction has been maintained between two categories of interaction. These have been termed 'operational' and 'biological' interactions respectively, and are defined and discussed in the Report of the IUCN Workshop on Marine Mammal/Fishery Interactions (IUCN 1981). Whereas the distinction between such categories is often blurred, it offers a useful platform on which to base an analysis of interactions between marine mammals and fisheries. In what follows some generalizations are attempted concerning the operational and biological interactions which have been reviewed.

Operational interactions

The records of operational interactions cited in this report suggest that no species of marine mammal can be excluded from the possibility of some conflict with fishermen. Inspection of the table on pages 165-7 indicates that most species, with the exception of the ice seals of Arctic and Antarctic waters, and most of the ziphiid whales, have been involved in operational interactions to some extent. The absence of reported interaction involving these species might be attributed to the scarcity or absence of fisheries in open ocean and polar waters.

Whereas some species appear to interact regularly with particular types of fishery throughout their ranges, the occurence of several highly improbable interactions prevents any overall categorization. The case of humpback whales annoying salmon fishermen in the Soviet Far East, and the reported presence of beaked whales on Japanese tuna longlines are two such examples.

The lack of adequate data concerning most recorded interactions also imposes limits on the extent to which these can be analysed or categorized. It is therefore generally impossible to establish the global extent to which any particular species or fishery is

involved in operational interactions. As might be expected, however, coastal species are most often cited in reports of conflict, with gill nets in particular being responsible for a high proportion of all incidental captures of marine mammals. The data are also too sporadic for an analysis of the fish species most often involved in operational interactions. High value fish such as tuna and salmon figure prominently in the reports as these are the species most often fished for with gill nets, and are also the ones which, when damaged in the nets, provoke the most vociferous complaints from fishermen.

The most frequently reported form of interaction is undoubtedly the incidental capture of marine mammals, especially small cetaceans. Depredation of the catch and damage to gear are by no means infrequent; these are more important with regard to pinnipeds. The existence of a third category of operational interaction should not be overlooked. A few species of small cetacean have been reported to assist fishermen in the capture of fish, which may represent the one area where the interests of fishermen and marine mammals coincide.

The available data on operational interactions are in general patchy. Throughout much of the world small scale and artisanal fisheries are, and to some extent at least, probably always have been, in conflict with a number of marine mammal species. For many of these fisheries there is little or no information on the problem, beyond often almost anecdotal references to incidental captures. Exceptions to this are confined largely to areas near to fishery reasearch stations, especially in Japan, North America and Europe. Away from such places, in much of South America, Asia and Africa, scattered coastal communities fish over extensive areas, where data collection may be very difficult. The collection of data may also be made difficult where fishermen are not well disposed towards marine mammals.

In contrast to this situation, some large scale or industrial fisheries have yielded extensive data on the capture of small cetaceans. Notable examples of this are the U.S. tuna purse seine fishery in the Eastern Tropical Pacific and the Japanese drift net fishery for salmon in the North Pacific. Although other fisheries, such as some of the industrial fisheries off the west coast of Africa, as yet provide little data, the collection of data from such enterprises would appear to be much easier, in principle, than from small scale fisheries.

Much of the reported interaction between marine mammals and fisheries does not appear likely to have a particularly significant effect on either the economy of the fishery or the population dynamics of the marine mammal species. Those examples where the conflict may be considered to be significantly affecting either the fishery or the marine mammal population may be characterized in one of two ways. There is either an important loss of fish or of gear suffered by the fishery, or else the number of marine mammals caught in the gear represents a relatively high proportion of the total population. For example the rate of catch may exceed the rate at which the population is able to grow. Examples of the first are provided by the coastal fisheries in Newfoundland, where cod traps damaged by whales may cost thousands of dollars to replace or repair. In Scotland, the Baltic and the North Pacific damage to catches of salmon also represents an appreciable loss to fishermen. Examples of the second case may be provided by the incidental mortality of thousands of Dalls porpoises in the North Pacific.

The impact of incidental captures of marine mammals is accentuated where the population is small or localized. For example river dolphins may be confined to a relatively small area and any incidental capture of these species may have a considerable affect on the population, which may not be very large in the first case. Some species of severely depleted baleen whale could also be affected in much the same way by any incidental captures. Dugongs and possibly some other species, being relatively localized in their distribution, may be prone to local depletion through incidents in fishing nets.

In an analogous manner, the impact of marine mammal depredation on commercially valuable fish and damage to fishing gear is accentuated where the fishermen are most dependent on the income from their fishing activities. Where opportunities of employment in other areas are readily available the effect may not be as severe as in a community totally dependent on fishing for its income.

In many areas increased pressure on fish stocks would seem likely to lead inevitably to further conflicts with marine mammals. In some areas offshore or remote fish stocks have yet to be exploited, and these may bring fishermen into conflict with marine mammal species, including those which at present are not reported to be involved in any interactions. Perhaps more significantly an increase in conflict between marine mammals and fishermen might be expected from the increase in the use of synthetic monofilament gill nets, which has been noted by a number of authors (Mitchell 1975, Gaskin 1983, e.g.). Such nets are used to catch a great range of fish species, but their relative invisibility to marine mammals, together with their strength and durability, means that marine mammals are increasingly in danger of entanglement and drowning. The problem is exacerbated where synthetic nets break away from their moorings and whilst no longer producing a useful catch, may drift around the sea for years, entangling and killing both mammals and fish. The problem exacerbated where synthetic nets break away from their moorings and whilst no longer producing a useful catch, may drift around the sea for years, entangling and killing both mammals and fish. It would seem inevitable that as the use of these nets increases, so too the problem of incidental marine mammal mortalities will intensify.

Just as increased fishing effort may lead to further conflicts with marine mammals, so too, expanding marine mammal populations may lead to increased conflict with fisheries. Although examples of this may be rare at present, there are a number of baleen whale and seal stocks which are in the process of expanding, and this cannot be excluded as a potential source of conflict in the future.

Marine mammal populations, however are unlikely to expand at more than a few percent per year, whereas fisheries may expand by hundreds of percent a year. The emphasis on monitoring conflicts between the two might therefore sensibly be concentrated on monitoring changing fishing patterns rather than changes in marine mammal populations.

For most fisheries little or no monitoring of interactions with marine mammals occurs at present. Whereas in some fisheries the scale of the bycatch itself might be enough to indicate a serious affect on the marine mammal population, in many cases it would be neccessary to collect records not only of the numbers of animals caught, but also of the age structure of the catch before any assessment of the affect of the fishery on the population would be possible.

The assessment of damage by marine mammals to fisheries has been attempted in a number of fisheries, particularly in areas where fisheries are more developed. Such assessments may either take the form of regular inspection of the catch, or of the gear, for marine mammal damage. Unfortunately it is very difficult to obtain accurate data on the loss of revenue to a particular fishery as many immeasurable quantities are involved when trying to make such an assessment. Hopefully future studies may at least provide some baseline data from which comparisons may be made with damage levels in other fisheries.

As yet there appear to be no studies which have attempted to measure the possible benefit to fishermen from cooperation with marine mammals. This is clearly one form of interaction which will remain very difficult to quantify.

Where they are practicable, the solutions to operational conflicts seem likely to be technological. Monofilament nets have already reduced the amount of damage to some net fisheries (albeit wile increasing incidental catches of marine mammals), and changes in gear design and fishing practice have greatly reduced the numbers of small cetaceans taken in the U.S. Pacific tuna fishery. The reduction of marine mammal population sizes may be unlikely to benefit fishermen with regard to operational interactions, as a few animals can be responsible for most of the damage. An example is seen in the case of the grey seal which is responsible for similar levels of damage to salmon fisheries in Scottish and Baltic waters, despite an order of magnitude difference in the sizes of the two populations.

Technological solutions, where possible, seem likely to include the development of seal scaring devices and netting which is more visible to marine mammals, without affecting its ability to catch fish. The development of such devices must be considered a priority in the solution of these problems.

Biological interactions

If an increase in fishing effort is likely to produce an increase in the number of operational interactions, the concomitant increase in fishing mortality might be seen as likely to increase the likelihood of biological interaction. Indeed the two may proceed together. It may be that as a fish stock becomes less abundant, marine mammals, particularly seals, may come to regard fishing nets as the most economic source of food.

The biological interaction between marine mammals and fisheries might be seen as competition between two predator species for a common prey, but the extent of the competitive overlap in feeding 'niches' is invariably extremely difficult to assess. A species which for example feeds in part on a commercial fish species may not be preying on the same population of that fish as the fishery. Most marine mammals also have extremely varied diets which may change not only from year to year, but also from month to month, area to area, and from one year class to the next. This variability in diet makes the extent of any competition very difficult to assess.

The variability in the diet of most marine mammals may also provide some form of safety valve in the competitive overlap with fisheries. The efficiency of many modern fishing methods may mean that a depleted fish stock becomes an energetically unappealing food source for marine mammals long before it becomes economically unattractive to the fishery, provoking marine mammals to feed on alternative food species.

The exception to this possibility arises where a marine mammal is more or less monophagous, or where it feeds on a group of food items which is affected by a fishery. Such marine mammal species are most vulnerable to competition with fisheries, as any change in prey abundance cannot be met with an appropriate change in diet.

Conversely, specialized fishermen are also vulnerable to marine mammals. In theory a marine mammal population, particularly an expanding one, could reduce either the average size of a prey population, or the number of prey in the population, to such an extent that fishing for that species becomes uneconomic. Multispecies fisheries, such as the increasingly common gill net fisheries, avoid the consequences of such competition as they fish for a wide variety of species.

Viewing marine mammals and fisheries as two predators in an ecological system highlights the fact that not all biological interactions between the groups need necessarily be competitive. Even for those which are, it is very unlikely that the two groups will cover exactly the same 'niche-space'. In many cases the ramifications of the predator prey complex may serve to reduce the amount of competition between the two groups.

In such circumstances the ecological effect of one group could be beneficial to the other, by for example, reducing the numbers of a predatory fish, which may affect the abundance of another, target, or prey species.

The above considerations suggest that it is very unlikely that there will be a weight for weight equivalence in the prey of marine mammals and the yield of a commercial fishery. This also makes it very difficult to assess the effect of one group on the other, and consequently difficult to define a situation where the reduction of marine mammal stocks may be justified for fishery protection, or where a reduction in fishing effort may be justified for the protection of marine mammal food supplies. Clearly, however, care must be exercised when considering a marine mammal population which is not numerous or which is confined spatially or ecologically. Care must also be exercised in considering a fishery which is 'confined' in a similar way, as if for example only one relatively uncommon species is being caught.

As fishing pressure intensifies globally and as marine mammals are more frequently brought into conflict with fisheries, demands for investigation into the competitive overlap between the two groups is likely to grow. The recovery of certain marine mammal stocks may produce the same demands. In such circumstances the neccessity for increased monitoring may become paramount. This may be particularly important in the development of squid fisheries, where a vast potential exists for squid fishing, and for competitive interaction with marine mammals. An early appreciation of the possible problems in such a

development would clearly be desirable.

The review presented above suggests that very little analysis of the biological interaction between marine mammals and fisheries has been possible to date. This has largely been because of the complexity of the problem. Fishery interests have frequently complained that marine mammals are responsible for the depletion of fish stocks, particularly evident where marine mammals are involved in gear interactions and are seen to eat commercial species, or are increasing in numbers. It would appear that to date no deleterious effects on fish stocks have been wholly substantiated by subsequent analysis.

The complexity of the interaction is not the only impediment to such studies, and another major feature in this problem is that feeding data for most species of marine mammal are extremely poor. Much information is semi-anecdotal, and may even be heavily biased through a very few observations. It is clear therefore that before any adequate analysis of the problem of biological interaction between marine mammals and fisheries is possible, considerably more data on the diets of marine mammals needs to be collected. In itself, however, such information will not necessarily be of much use. What is perhaps more important for the understanding of this problem is a knowlege of the feeding stategies of marine mammals, and much more about the inter-species population dynamics of the fish and marine mammal species concerned.

TABLE SUMMARIZING INTERACTIONS

Population sizes given are guessed wherever the estimate is followed by '?'.

Column 1 refers to the number of statistical areas in which operational interactions have been recorded.

Column 2 refers to those areas in which the interaction is regarded as being of particular significance to either a marine mammal population or a fishery

Column 3 indicates whether or not commercial species are regularly included in the diet. A '-' indicates either that commercial species are not regularly included in the diet or that the regular composition of the diet is unknown.

Column 4 indicates the statistical area in which the consumption of commercial species may be regarded by fishermen as a threat to fish stocks, or the commercial catch may affect the marine mammal's population dynamics.

Species name	Est.Pop.	1	2	3	4
CETACEA					
Balaenidae:					
Eubalaena glacialis	>2000	3	-	Yes	-
Balaena mysticetus	5000	-	-	-	-
Caperea marginata	'000's?	1	-	-	-
Eschrichtidae:					
Eschrichtius robustus	11000	-	-	-	-
Balaenopteridae:					
Balaenoptera physalus	122000	2	-	Yes	21 27
Balaenoptera musculus	10000	-	-	Yes	-
Balaenoptera acutorostrata	>700000	3	21	Yes	21 27
Balaenoptera borealis	100000	-	-	Yes	-
Balaenoptera edeni	'00000's?	-	-	Yes	-
Megaptera novaeangliae	<10000	2	21	Yes	21
Ziphiidae:					
Tasmacetus shepherdi	'000's?	-	-	Yes?	-
Berardius arnuxii	'0000's?	-	-	-	-
Berardius bairdii	'0000's?	-	-	-	-
Mesoplodon pacificus	'000's?	-	-	-	-
Mesoplodon bidens	>000's?	-	-	-	-
Mesoplodon densirostris	>000's?	-	-	-	-
Mesoplodon europaeus	>000's?	-	-	-	-
Mesoplodon layardii	>000's?	-	-	-	-
Mesoplodon hectori	>000's?	-	-	-	-
Mesoplodon grayi	>000's?	-	-	-	-
Mesoplodon stejnegeri	>000's?	-	-	-	-
Mesoplodon bowdoini	>000's?	-	-	-	-
Mesoplodon mirus	>000's?	-	-	-	-
Mesoplodon ginkgodens	>000's?	1	-	-	-
Mesoplodon carlhubbsi	>000's?	-	-	-	-
Ziphius cavirostris	'0000's?	-	-	-	-
Hyperoodon ampullatus	'0000's?	-	-	Yes	-
Hyperoodon planifrons	'0000's?	-	-	-	-

Physeteridae:					
Physeter macrocephalus	1000000?	1	-	Yes	-
Kogia breviceps	'0000's?	1	-	-	-
Kogia simus	'0000's?	1	-	-	-
Monodontidae:					
Monodon monoceros	>10000	-	-	Yes	-
Delphinapterus leucas	>30000	2	-	Yes	27
Delphinidae:					
Steno bredanensis	'0000's?	2	-	-	-
Sotalia fluviatilis	'0000's?	2	31 34	Yes	-
Sousa chinensis	'0000's?	2	-	-	-
Sousa teuszii	'000's?	1	-	Yes	-
Orcaella brevirostris	'0000's?	2	-	-	-
Peponocephala electra	'0000's?	3	-	-	-
Feresa attenuata	'0000's?	2	-	-	-
Pseudorca crassidens	'00000's?	>4	61	Yes	61
Orcinus orca	'00000's?	5	51 57	Yes	27
Globicephala melaena	'00000's?	4	-	Yes	-
Globicephala macrorhynchus	'00000's?	2	-	-	-
Lagenorhynchus albirostris	'00000's?	-	-	Yes	-
Lagenorhynchus acutus	'00000's?	1	-	Yes	-
Lagenorhynchus obscurus	'00000's?	4	41	-	-
Lagenorhynchus cruciger	'00000's?	-	-	-	-
Lagenorhynchus australis	'0000's?	2	41 87	-	-
Lagenorhynchus obliquidens	100000?	1	61	Yes	-
Lagenodelphis hosei	'0000's?	2	-	-	-
Tursiops truncatus	'000000's?	12	61 71	Yes	-
Grampus griseus	'00000's?	4	-	-	-
Stenella longirostris	'000000's?	6	77	-	-
Stenella coeruleoalba	'000000's?	4	61	-	-
Stenella attenuata) Stenella dubia) Stenella frontalis) Stenella plagiodon)	'000000's?	3	77	-	-
Stenella clymene	'0000's?	-	-	-	-
Delphinus delphis	'000000's?	9	31 51 57	Yes	37
Lissodelphis peronii	'00000's?	1	-	-	-
Lissodelphis borealis	'00000's?	1	-	-	-
Cephalorhynchus heavisidii	>'000's?	1	-	-	-
Cephalorhynchus eutropia	>'000's?	2	-	-	-
Cephalorhynchus hectori	>'000's?	1	-	-	-
Cephalorhynchus commersonii	'0000's?	2	-	-	-
Phocoenidae:					
Phocoena phocoena	'000000's?	6	21	Yes	-
Phocoena sinus	'000's?	1	77	Yes	-
Phocoena spinipinnis	'00000's?	2	87	Yes	-
Phocoena dioptrica	>'000's?	1	-	-	-
Phocoenoides dalli	'000000's?	2	61	-	-
Neophocoena phocaenoides	'00000's?	4	51 57	Yes	-
Platanistidae:					
Platanista gangetica	4-5000	1	57	-	-
Platanista minor	450-600	1	51	-	-
Inia geoffrensis	'00000's?	2	31 41	Yes	-
Lipotes vexillifer	'00's?	1	61	-	-

Pontoporia blainvillei	'000's?	1	41	Yes	-
PINNIPEDIA					
Otariidae:					
Eumatopias jubatus	230000	3	67	Yes	-
Zalophus californianus	95-115000	2	67 77	Yes	-
Otaria flavescens	273000	2	41 87	Yes	-
Neophoca cinerea	3-5000	1	57	-	-
Phocarctos hookeri	4000	1	81	-	-
Callorhinus ursinus	1765000	2	61 67	Yes	67
Arctocephalus townsendi	500	-	-	-	-
Arctocephalus philippii	>1000	1	-	Yes	-
Arctocephalus galapagoensis	1-5000	-	-	-	-
Arctocephalus australis	320000	2	-	Yes	-
Arctocephalus pusillus	870000	3	47	Yes	47
Arctocephalus forsteri	>38000	1	-	Yes	-
Arctocephalus gazella	400000?	-	-	Yes	48
Arctocephalus tropicalis	20-120000	-	-	Yes	-
Odobenidae:					
Odobenus rosmarus	160000	1	-	-	-
Phoca vitulina	400000	4	67	Yes	-
Phoca largha	>250000	1	-	-	-
Phoca hispida	6-7000000	2	-	-	-
Phoca sibirica	50-60000	-	-	-	-
Phoca caspica	500-600000	-	-	-	-
Phoca groenlandica	>12000000	2	27	Yes	21
Phoca fasciata	200-250000	-	-	-	-
Erignathus barbatus	500000	1	-	Yes	-
Cystophora cristata	500-600000	2	-	Yes	-
Halichoerus grypus	130000	2	27	Yes	27
Monachus monachus	500-800	1	37	Yes	-
Monachus tropicalis	0	-	-	-	-
Monachus schauinslandi	700-1000	1	-	-	-
Mirounga leonina	600000	-	-	Yes	-
Mirounga angustirostris	45000	1	-	-	-
Lobodon carcinophagus	15000000	-	-	Yes	-
Ommatophoca rossi	220000	-	-	-	-
Hydrurga leptonyx	500000	-	-	-	-
Leptonychotes weddelli	750000	-	-	-	-
SIRENIA					
Trichechidae:					
Trichechus senegalensis	'000's?	1	34	-	-
Trichechus manatus	'000's?	1	31	-	-
Trichechus inunguis	>10000?	1	41	-	-
Dugongidae:					
Dugong dugon	>10000?	4	51 57 77	-	-

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